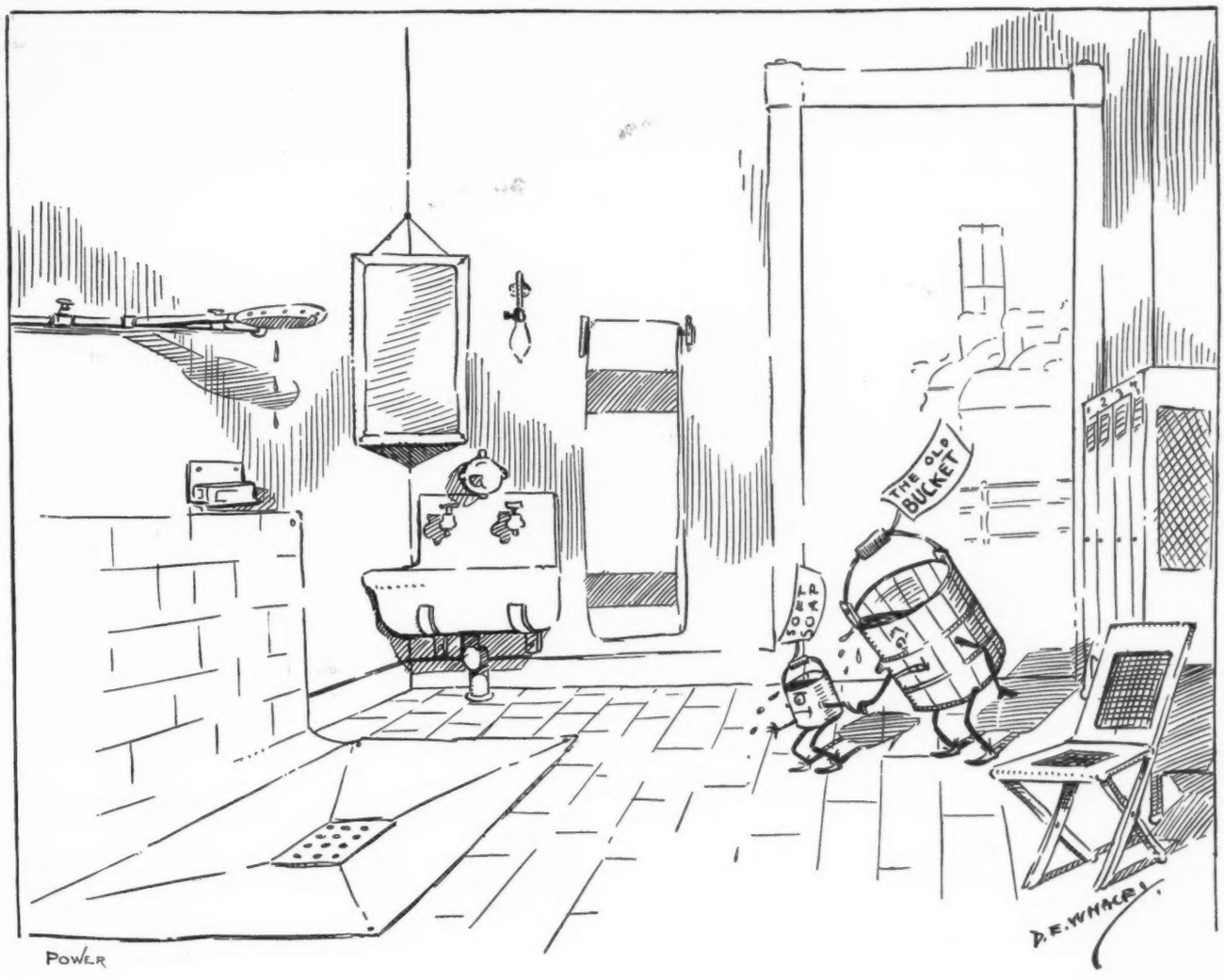
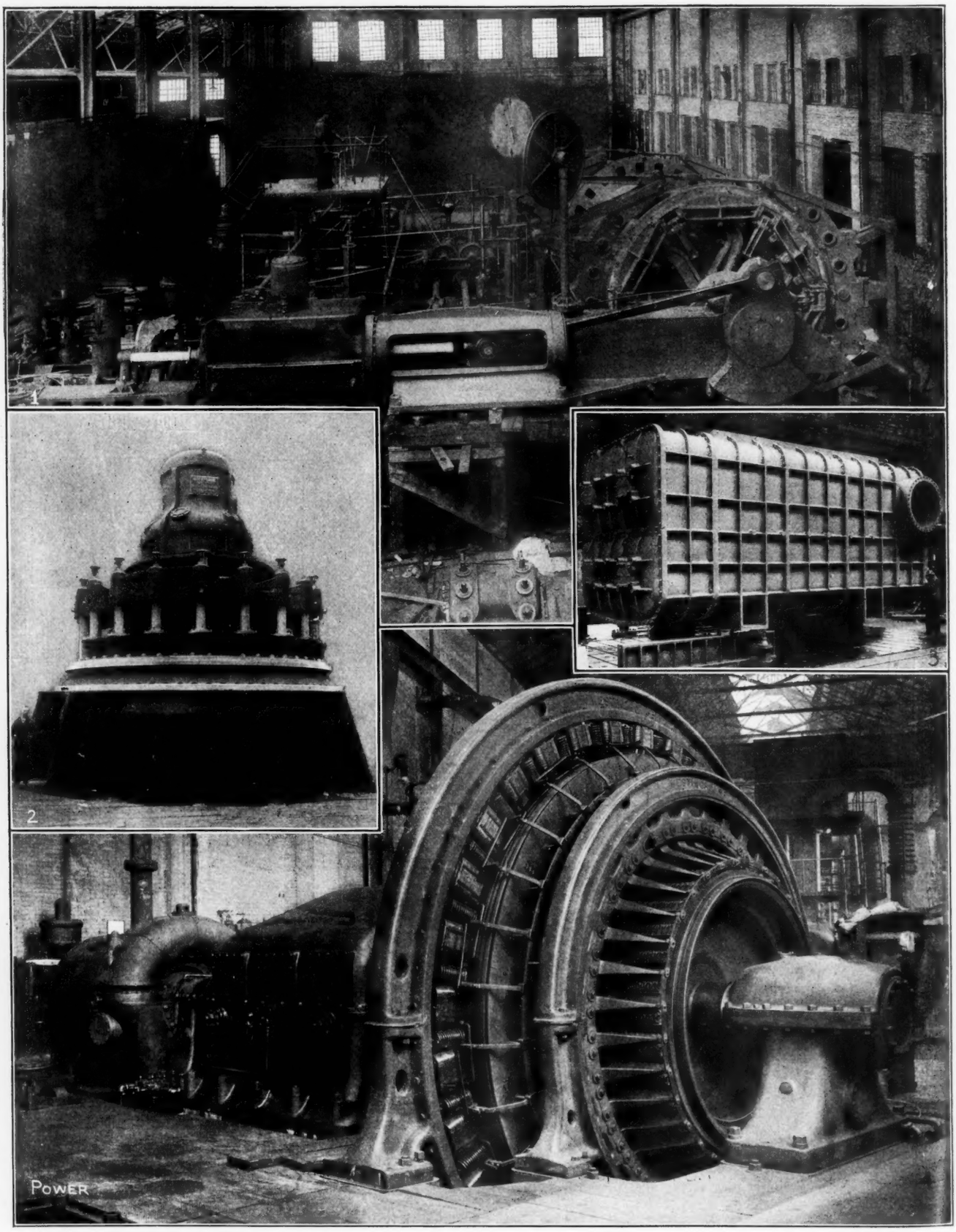
# POWER

Vol. 38 NEW YORK, JULY 22, 1913 No. 4

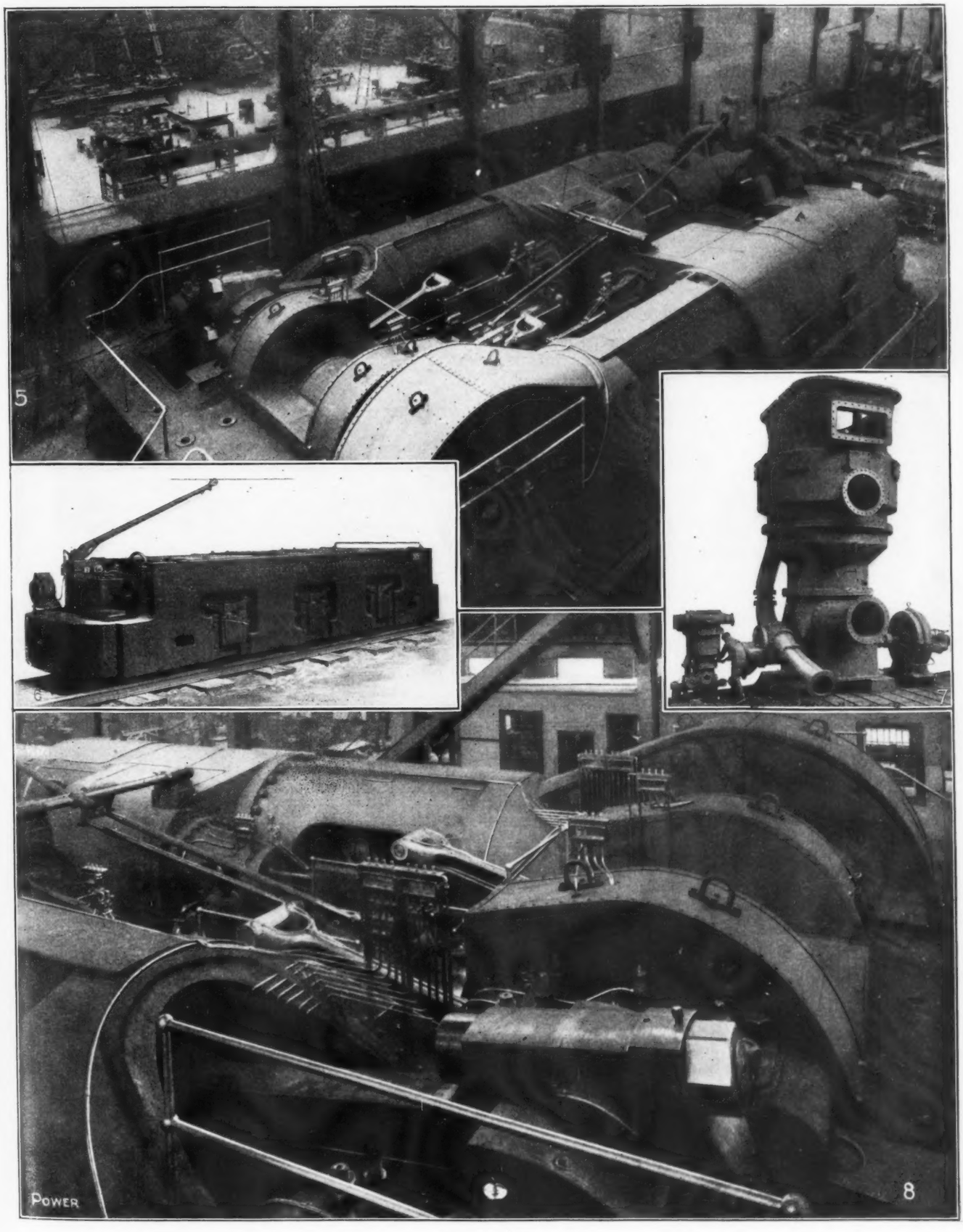
## Not Wanted




THE BUCKET: "COME ON, OLD CHAP; THERE'S NO PLACE FOR US AROUND HERE."




Largest Known Units of Their Kind in the World. Fig. 1. Twin, 34 and 34x72-In. Nordberg Hoisting Engine. Fig. 2. A 10,000-Hp. Turbine at Keokuk, Weighing 1,000,000 Lb., Cast in One Piece by the Wellman-Seaver-Morgan Co. Fig. 3. Westinghouse Surface Condenser to Serve a 20,000-Kw. Turbine, Condensing 300,000 Lb. of Steam per Hour. Fig. 4. Geared 3750-Kw. Shunt-Wound D. C. Westinghouse Generator




FIGS. 5 AND 8. MESTA TWIN TANDEM-COMPOUND ROLLING-MILL ENGINE. HIGH-PRESSURE CYLINDER, 46-IN. LOW-PRESSURE CYLINDER 76 IN., STROKE 60 IN. FIG. 6. THREE-MOTOR, 25-TON JEFFREY ELECTRIC MINE LOCOMOTIVE. FIG. 7. WESTINGHOUSE-LE BLANC JET CONDENSER TO SERVE A 12,500-KW. TURBINE, CONDENSING 150,000 LB. OF STEAM PER HOUR

# Duchesne's Experiments on Superheat

By Prof. R. C. H. Heck

*SYNOPSIS—Duchesne determined the specific volume of steam by using the steam-engine cylinder, during the operation of compression, as the containing and measuring vessel. He got the quantity of steam present by an assumption of homogeneity of steam condition throughout the compression space. It is shown that his method has led to values as much as 40 per cent. greater than what is physically possible.*

*The determinations of total heat were made by the method of water calorimetry. While this method was used by Regnault, it is not of the highest accuracy, and has been abandoned by the more skillful of the later experimenters. The results of Duchesne show good instrumental work, in that they are consistent among themselves. But an error is made in assuming that they are in accord and can be combined with Regnault's values at saturation. And in the variation of total heat with pressure for a given temperature they show rates of change far greater than can be accepted as possible.*

The writer has recently had occasion and opportunity to make a critical examination of the full report of the Duchesne experiments on certain properties of superheated steam, an abstract of which was published in Power for July 23, 1912. The results deduced from those experiments disagree radically with the great body of data which has gradually been formulated into our modern steam tables. If they are valid, the steam tables are ready for the scrap heap; but it is not difficult to find errors or inaccuracies in the work of Duchesne quite sufficient to account for the discrepancies which appear.

This work divides itself into two distinct sections, concerned with specific volume and with total heat, respectively. The scheme followed in determination of volume is outlined in Fig. 1. The cylinder of a steam engine served as containing vessel, volume and pressure were measured from the compression curve of the indicator diagram, variant steam temperature was given by the "hyperthermometer," and weight of steam present was inferred through an assumption of homogeneity which works out badly.

The engine is approximately of 12 in. diameter and 24-in. stroke. The head end, which alone was used in these experiments, has a piston displacement of just 1.52 cu.ft., and the clearance volume (increased in order to accommodate very long compressions) was 8.6 per cent. of the displacement. The clearance distance shown in Fig. 1 bears, of course, a smaller ratio to the stroke $MN$. As nearly as can be inferred from vague information, the wires of the hyperthermometer or multiple-junction thermocouple lie in a plane about 1 in. from the cylinder head, as indicated by line $TT$. The engine was operated at a speed of either 15 or 30 r.p.m.

## Duchesne's Scheme for Measuring Specific Volume

The curves plotted in Fig. 1 show steam temperature on a base of piston position, two typical experiments being represented. In No. 11 the engine was run condensing, in No. 20 noncondensing. Curve $a$ in either case gives observed steam temperature, while curve $b$ is laid out by taking the saturation temperature corresponding to indicated pressure; then any vertical distance between the curves shows superheat existing. The distinctive feature of No. 20 is found in the fact that the two curves coincide at first, then separate at a point $K$ where superheating begins. Duchesne assumes that at this point the whole body of steam has arrived at a uniform state of dry saturation, throughout the contained space, so that with density read from the steam table its exact weight becomes known. And when there was superheating even at the beginning of compression, as in experiment 11, it was still assumed that the steam was uniform in condition and due allowance (or, as will appear later, undue and excessive allowance) was made for this initial superheat.

## Volumetric Experiments of Knoblauch, Linde and Klebe

Contrast with this the Munich experiments, which were published in 1905. Into the glass bulb $B$, Fig. 2, was introduced, over mercury, a small and very accurately weighed quantity of pure water. In any experiment, saturated steam from a boiler filled the cast-iron cylinder $A$; and with the water in $B$ all evaporated, the mercury level was kept at a height $LL$ in tube $P$, which tube led to the manometer. Both pressure and temperature of the steam in $A$ were read; and since steady conditions could easily be maintained for any needed length of time, existence of the same temperature in $B$ was assured. Even the stem $P$ was surrounded by the steam bath to a point below the mercury level, the latter being observed through glass windows $WW$. For superheat in $B$ there had to be higher pressure in $A$, which the glass vessel was strong enough to sustain. Several of these bulbs were used, of capacity ranging from 104 to 183 cu.in.

## Comparison of Volume Results

A comparison of results is made in Fig. 3. Consider first the full lines, which represent a formulation based on the Munich experiments and checked by other reliable data. In general, if superheated steam or gaseous $H_2O$ were a perfect gas, it would exactly follow the law

$$pv = BT \qquad (1)$$

Here $p$ is absolute unit pressure, $v$ is the volume of a unit weight of the gas, $T$ is absolute temperature, and $B$ is the gas constant, fixed by the molecular weight of the substance. With our ordinary practical units, or with $p$ in pounds per square inch above perfect vacuum, $v$ in cubic feet to the pound of steam, and $T$ in Fahrenheit degrees (so that it equals thermometer reading $t$ plus 460), the value of $B$ is 0.596, as against 0.370 for air. This 0.596 corresponds with 47.1 for kilograms per square meter, cubic meters to the kilogram, and centigrade degrees. The gas constant is a quantity of the first importance in any attempt to relate volume to pressure and temperature.

Far from saturation or liquefaction, actual gases conform closely to the law $pv = BT$. But as they approach saturation there is a gradual shrinkage of the pressure-volume product $pv$ from the ideal value $BT$. The formula

connecting pressure, volume and temperature, or the characteristic equation of steam, may then be most simply written as

$$pv = BT - X \qquad (2)$$

where $X$ stands for a complex corrective or modifying term. This $X$ depends upon both pressure and temperature; it increases with higher pressure, but for any pressure it has a maximum value at saturation and decreases as temperature rises.

In Fig. 3, the base is temperature, the ordinate is product $pv$ for 1 lb. of steam, and the operation represented is heating (or cooling) under constant pressure. In the full-line diagram, straight line $AA$ represents equation (1), since it shows $pv$ varying with $t$ or $T$ in constant ratio. Produced toward the left, $AA$ would cut the line of zero $pv$ at absolute zero of temperature. Curves $BC$, $DE$ and $FG$ are actual lines of constant-pressure expansion, having their lowest points on the saturation curve $BFH$ and continually approaching $AA$ as temperature rises.

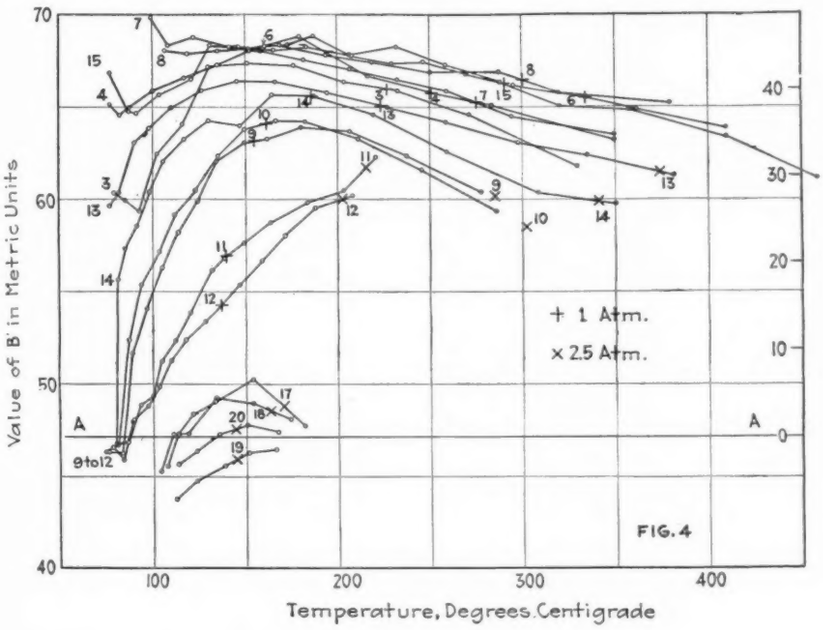
Lines $BC$ and $DE$ are for 1.0 and 2.5 atmospheres absolute pressure, the same as the dotted Duchesne curves 1 and 2.5 above. Within the low-pressure range of the experiments, the shrinkage term $X$ is small. To show larger values, curve $FG$ is laid out for 250 lb. absolute. Of course, any vertical intercept such as KL represents a particular value of $X$. The vertical $FN$, dropping from the saturation line, shows how the line of constant-pressure change runs into the region of steam-and-water mixture.

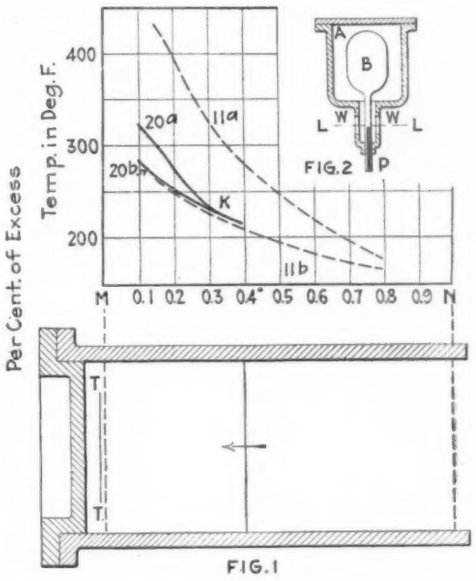
The points which determine dotted curves 1 and 2.5 in Fig. 3 represent the writer's interpolations in Duchesne's tables of readings, each point bearing the number of the experiment from which it comes. The curves here drawn agree in form with those of the original report, which have been reproduced in Fig. 2 on page 111 of POWER for July 23 last. The striking features of these curves are, a start in the region of line $AA$, a steep climb to excessive values of $pv$, then quite good conformity to the law $pv = BT$, except that $B$ is much too big and is not the same for the two pressures. Straight lines $A'A'$ and $A''A''$ pass through the absolute zero of temperature like $AA$, therefore, each represents an equation of the form $pv = BT$.

Now there is absolutely no reason in physical science for believing that the pressure-volume measure $pv$ for 1 lb. of steam can possibly extend above the ideal gas line $AA$ in Fig. 3. The unavoidable alternative is the belief that the Duchesne values of $pv$ are too big, or that they really belong to more than the unit weight of steam.

## Duchesne's Values of Product pv

The method of getting numerical values of $pv$ from the experimental data is to take the product of measured pressure and volume and divide it by assumed steam weight $M$. If $M$ is less than the true weight present, $pv$ will be too large; conversely, if $pv$ is greater than $BT$, it must correspond with more than the unit weight. An







analysis along the line of these ideas is given graphical form in Fig. 4. Without going into the detail of the psychological processes by which Duchesne gets at his values of steam weight $M$, the purpose is to try out his results against the criterion of underlying physical principle.

The scheme here employed is then, to take $pv$ as given for the kilogram of steam, divide it by the corresponding $T$, and plot in Fig. 4 the quotient

$$B' = \frac{pv}{T} \qquad (3)$$

This $B'$ is not a constant; but if the derived values of $pv$ were really correct and consistent, it would come out just a little smaller than the true constant $B$, the difference varying with pressure and temperature after a manner suggested by the relation of curves $BC$ and $DE$ to line $AA$ in Fig. 3. The quantities being left in the original units, horizontal line $AA$, at the height 47.1, here represents the true value of $B$, which $B'$ ought not to exceed. A scale at the right shows percentage of excess of $B'$ over $B$.

In Fig. 4, the points belonging to each experiment are strung together by short tie lines to form a rough curve.

Sixteen experiments were worked up. In amount of compression, expressed as a fraction of the stroke, and in speed of engine, they classify as follows:

RUNNING CONDENSING

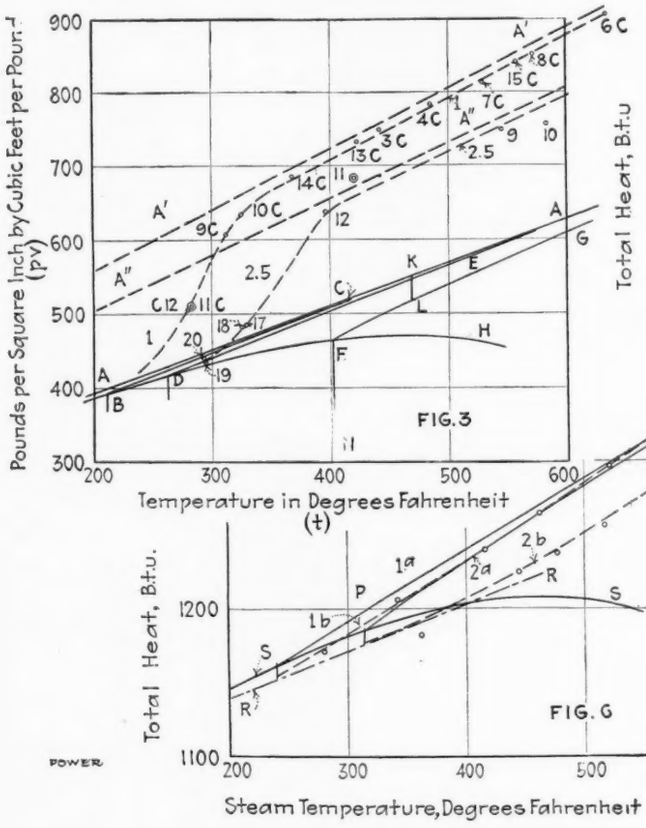
| | |
|---|---|
| Compression 0.9 | No. 15 |
| Compression 0.8 | Nos. 9, 10, 11, 12 |
| Compression 0.75 | Nos. 13, 14 |
| Compression 0.65 | Nos. 3, 4 |
| Compression 0.6 | Nos. 6, 7, 8 |

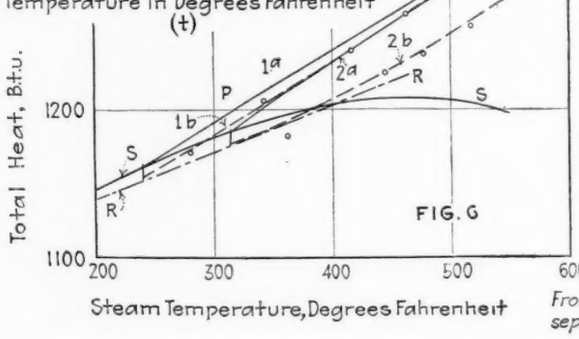
NONCONDENSING

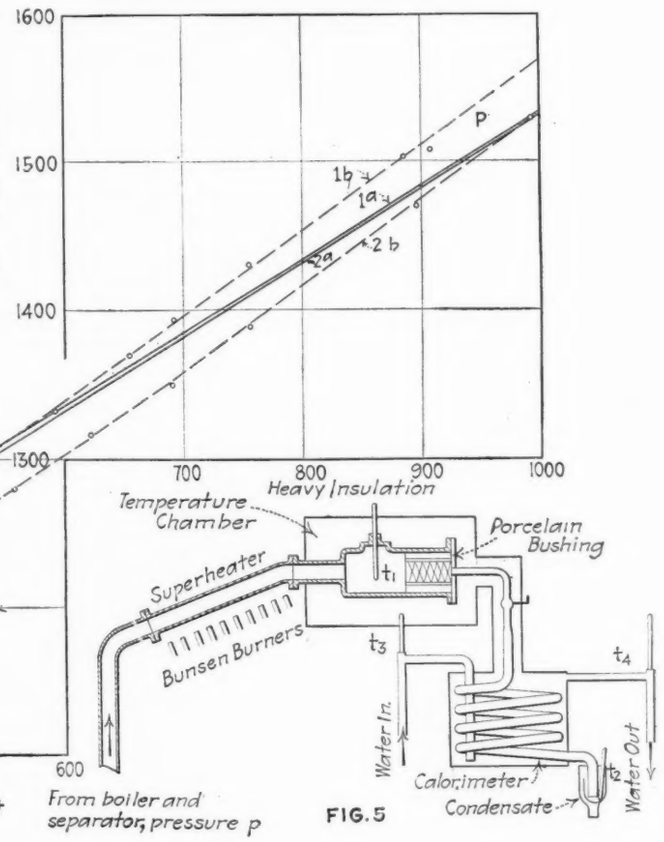
| | |
|---|---|
| Compression 0.4 | Nos. 17, 18, 19, 20 |
| Speed about 15 r.p.m. | Nos. 6, 9, 10, 15, 17, 18 |
| Speed about 30 r.p.m. | Nos. 3, 4, 7, 8, 11, 12, 13, 14, 19, 20 |

A marked and rapid rise of $B'$, most strikingly shown in the Nos. 9 to 14 group of curves, surely indicates reevaporation continuing past the point where Duchesne assumed uniformity of condition and absence of moisture; in other words, there are increases in the amount of water substance present in gaseous form. The curves in another group, made up of Nos. 4, 6, 7, 8 and 15, show practically none of this initial rise, but they begin and have their whole course in a region about 40 per cent. above any possible true value for the kilogram of steam. Evidently, there was something radically wrong with the method of allowing for initial superheat when estimating steam density.

Large cross-marks on the curves in Fig. 4 locate the points interpolated for plotting in Fig. 3, and thus give some idea of the relation of pressure to the quantities here diagrammed. The evolution of Duchesne's curves of constant-pressure expansion can be traced out in this diagram, but a detailed discussion is hardly worth while. One matter of interest is the drop of nearly all the $B'$ curves, with rise of temperature, after passing a maximum. This is what makes the upper part of curve 2.5 in Fig. 3 lie so much below curve 1.




## The Assumption of Homogeneity

Is there any reason to assume uniformity of steam condition throughout the compression space of an engine cylinder at any instant? Powerful influences exist which tend to produce variation, and there is strong evidence that variation once established will disappear slowly.

During the last part of compression and during admission, a portion of the steam within or entering the cylinder is condensed by cooler metal walls. On some surfaces the water of condensation probably lies more or less quietly, in a film, until pressure falls. But where steam rushes over a surface, the moisture will be swept off as rapidly as formed, and mixed with the body of steam. When pressure falls in expansion and at release, a wall that is wet will dry itself, partly by straight reëvaporation, partly by mechanical action; that is, a layer of steam formed between metal and water will throw the latter off into space. A wall already swept dry will at once begin to dry and superheat the steam in contact with it. The larger body of steam, away from the walls, contains moisture thus swept or thrown from the walls and also moisture due to loss of heat in work performed.

It is futile to claim that even a multijunction thermocouple, located in a plane parallel to the cylinder head as indicated by line $TT$ in Fig. 1, is in position to measure the average temperature of the whole mass of steam in the cylinder, especially during the early part of compression, although its position becomes relatively better as the piston gets closer to the head. Of all the surfaces of the cylinder proper (in distinction from the steam passages), the face of the head is most definitely swept by the current of entering steam. This surface is, therefore, ready to begin superheating promptly. A layer of

steam initially dry or slightly superheated will have its temperature rapidly elevated by the work of compression, while an adjacent body of initially wet steam must be dried by the same source of heat before its temperature can rise above that of saturation. In the experiments, the thermocouple is located just where the rapid superheating which it shows is most strongly favored.

### Determination of Total Heat

Total heat was measured by the method of the continuous water calorimeter, with the apparatus arranged as sketched in Fig. 5, where all nonessential detail has been omitted. Temperature $t_1$ of the superheated steam was got by a bare mercury thermometer entering through a stuffing box and by the thermocouple. The other temperatures, all of low range, were taken with fine mercury thermometers. Numerical values from one of the three experiments which are reported in full will give an idea of the size of the quantities involved.

| | | |
|---|---|---|
| 1 | Number of experiment | 40 |
| 2 | Absolute steam pressure, lb. | 69.7 |
| 3 | Saturation temperature, deg. F. | 302.7 |
| 4 | Temperature of superheated steam, $t_1$, deg. F. | 436.4 |
| 5 | Rate of condensation per hour, lb. | 5.48 |
| 6 | Temperature of condensate, $t_2$, deg. F. | 58.43 |
| 7 | Initial temperature of cooling water, $t_3$, deg. F. | 55.59 |
| 8 | Final temperature of cooling water, $t_4$, deg. F. | 59.35 |
| 9 | Rate of flow of cooling water per hour, lb. | 1704 |
| 10 | Apparent total heat by calorimeter, B.t.u. | 1190.5 |
| 11 | Correction for radiation beyond temperature chamber, B.t.u. | +53.9 |
| 12 | Expermental total heat, B.t.u. | 1244.4 |

The first thing to be noted is the small amount of steam put through the apparatus. With 70 lb. pressure, the rate of flow is 5.5 lb. per hr. The other two fully recorded experiments have the rates, 9.4 lb. at 84 lb. pressure, and 5.9 lb. at 28 lb. pressure. In the Knoblauch experiments on heat required for superheating the steam rate was from 60 to 110 lb. per hr.

The rise of temperature of the cooling water is between 3 and 4 deg., so that even with thermometers graduated to 0.01 deg., it is limited to the accuracy expressed by a three-figure number. And the other factor in calorimetry, the quantity of cooling water, is of no greater precision, because it was found by a float reading of the head over an orifice in a thin plate. With such data, it really seems foolish to carry the calculated heat values to three decimal places, or to six-figure accuracy (in calories). However, the results show excellent consistency in one direction, for the points agree very well with smooth curves traced through the several series belonging to the particular pressures.

A permissible question arises as to the validity of disregarding radiation from the temperature chamber, or of assuming that the temperature given by the hyperthermometer is truly representative. This chamber was about 2 in. in full diameter, but was contracted to something like half that size by a porcelain bushing, around the location of the thermometer wires. There certainly must have been some loss of heat through the lagging, which would cool the steam near the walls. The junctions of the thermocouple all lay right in the axis of the chamber and of the steam current, and the flow of steam was so gentle that some degree of annular stratification was likely to persist clear over to the orifice. The thermocouples used in the Knoblauch-Mollier experiments—which Duchesne, in a discussion in *Révue de Mécanique,* has erroneously taken for thermometer cups—being placed in the vertical ends of the serpentine coil itself, are a good deal more likely to have been subjected to the real, average temperature of the current of rapidly flowing steam.

The character of Duchesne's results is shown in Fig. 6, where points are plotted and curves drawn for two of the seven pressures at which series of experiments were made. No. 1 is for 26.9 lb. absolute, No. 2 for 84.2 lb., while the highest and lowest pressures were about 16 and 100 lb. Dotted curves 1*b* and 2*b* are from the tabulations in the report, but full-line curves 1*a* and 2*a* represent a formula for total heat recently established by the writer. These last run a few heat units higher than would similar curves from the Marks and Davis tables, but in the important matter of relative form and spacing there would be no distinguishable difference.

It need hardly be stated that the curves of class *PP* in Fig. 6 are lines of constant-pressure expansion. Curve *SS* is the writer's saturation line, straight line *RR* represents Regnault's formula for total heat of saturated steam. As has been remarked, the experimental points in Fig. 6 agree very well with their curves, except where the lower end of No. 2*b* is bent up to meet the Regnault value at saturation. The assumption that Regnault's total heats may thus be brought into combination with the present results is decidedly unwarranted, and is one of the chief reasons for the peculiar form of the curves of specific heat $c_p$ which have been derived by Duchesne in the course of his work.

The experiments plotted in Fig. 6 have two outstanding features. First, the general slope of the *b* curves is somewhat steeper than that of the writer's curves, which latter are based upon the Knoblauch-Mollier experiments. This accounts for the high prevailing value of $c_p$ in Fig. 4 of the article in Power of July 23, where the curve into which those for various pressures finally run ranges from 0.55 to 0.60 in. in height. But there is nothing in these experiments to inspire the confidence that would lead one to substitute them for the others as a basis of knowledge.

The second special feature is the great vertical distance between curves 1*b* and 2*b*. In the throttling experiments which have been made on steam and other gases we have definite (although not exceedingly precise) data as to the rate of change of total heat with pressure along lines of uniform temperature. The comparatively narrow distance between curves 1*a* and 2*a* in Fig. 6, and the gradual convergence of these curves as temperature rises, are not at all a matter of guesswork, but are wholly rational and in accord with the reliable data. Such a difference between the total heat at 27 lb. and 84 lb. pressure as the 35 B.t.u. between curves 1*b* and 2*b* is beyond the bounds of possibility.

### Specific Heat of Superheated Steam

Duchesne applies the thermodynamic relations between rate of expansion and specific heat as a partial determinant for $c_p$; but since his results for volume have errors running up to 40 per cent., they hardly furnish a foundation for mathematically derived quantities. His direct measurements of total heat are by a method insufficiently accurate for the detection of small variations, their combination with the Regnault values at saturation leads to misinterpretation, and the excessive variation with pressure casts doubt on their correctness, even though no obvious sources of large error are apparent in his work and the subsequent presentation.

# Welding Steam Boilers

*SYNOPSIS—The safety of water-tube boilers employing headers and the strength of welded seams.*

❖

The June number of the *Journal* of the American Society of Mechanical Engineers reviewed at some length an article on the above subject, which was written by H. Jaeger for *Zeitchrift für Dampfkessel und Maschinenbetrieb*. It appears that three serious explosions of water-tube boilers with headers occurred in Prussia during the year 1912. These explosions have attracted wide attention to the question of safety of this type of boiler and of welded seams in boilers in particular.

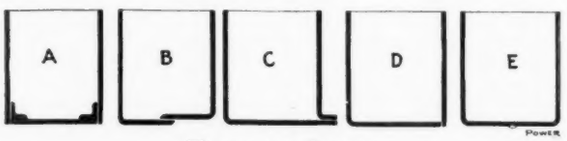
The first explosion was in the central station of the Phoenix Co., in Lierenfeld. The boiler was built in 1910 by the Borsic Co. It had 4408 sq.ft. of heating surface and worked under a pressure of 205 lb. gage. The immediate cause of the accident was the rupture of the flange plate in the lower part of the header which was 19.9 ft. wide and 10 in. deep. The second explosion occurred in the rolling mill of the Menden and Schwerte Steel Works, with a new Piedboeuf boiler built in 1911, having a header 11.7 ft. wide by 11.8 in. deep. The immediate cause of the explosion was the loosening of the welded seam of the header plate which sprung open up to the corners. In the third explosion at the rolling mill Deutscher Kaiser in Dinslaken, a wall of the rear header became loose at the welded seam and rolled up to the second row of stay-bolts. The boiler was built in 1897 for a working pressure of approximately 160 lb. and, as fuel, used furnace gases from the mill. In all three cases, the explosions were violent, the boilers being thrown 165, 190 and 20 ft., respectively.

Investigation showed that there were other causes besides possible weakness of the welded seams, which in themselves might have been sufficient to account for the explosions. In the Borsic boiler it was found that the lower welded seam of the header was exposed to the direct action of the gases, owing to insufficient protection by the boiler setting which had been defective for some time. Similar conditions were found in the Menden-Schwerte explosion, while in the Dinslaken accident, it was found that the lower row of stay-bolts was unusually far from the welded seam, 8.9 in., and in that row six stay-bolts were broken and several more cracked.

Both the Prussian Government and the manufacturers have organized a series of tests to determine the strength of welded seams generally. The Piedboeuf Co. has made a series of tests with butt-welded seams and found that rupture occurred only at stresses many times exceeding those to which the seam would be subjected in boiler operation. The fracture showed a brilliant surface colored here and there by oxidized iron slag, the same as the surface of fracture of the exploded boilers. Since all possible care was exercised in the preparation of the test seams, and the welded pieces were sufficiently warm, it appears that, with the present methods of work, inclosure of oxidized slag cannot be prevented. With thick sheets, such as are used in water-tube boilers, the specific pressure of the two welded surfaces against each other cannot be made great enough by hammering to force out from the joints the slag formed by the oxidizing-welding flame. The following subjects were also investigated:

1. The advisability of limiting the width and depth of the header, the former when there are two upper drums. The use of two headers side by side would be as economical in operation as the two upper drums, while the handling of excessively large headers would be avoided. On the other hand, with the present hoisting apparatus, the single header does not present any serious difficulty, while two units would be more expensive than one and the total length of welded joint would be longer with the two units. It was decided that there was no reason for recommending a limitation of the width of the headers.

2. The advisability of adopting a header design, avoiding the use of butt welding entirely, or at least eliminating the lower welded seams of the headers lying toward the fire side, was investigated. The following types were considered: (a) Return to the riveting of the headers, either by connecting the side plate with the straight walls by means of angle irons, as in sketch *A*, or as in the Willman boiler, sketch *B*, by riveting together the front and rear walls, provided for this purpose with broad flanges so that the rivet joint lies in the middle of the flanges serving as side plate. (b) By flanging both walls and making an external riveted seam, as in sketch *C*. (c) By flanging the fire wall and butt welding




TYPES OF JOINT

to it the outer wall, sketch *D*. (d) By flanging both walls and autogenously welding them in the middle, as shown in sketch *E*.

The design shown in sketch *A* is not advisable because it does not insure complete safety of operation and the row of rivets on the far side forms a weak place in the boiler. This also applies to the design shown in sketch *B*. A seam, such as is shown in sketch *C*, would be expensive to make on account of the tall flanges of the inner walls and, in addition, is not absolutely safe as to tightness on account of there being only a single calking edge. Some factories now contemplate the adoption of the design shown in sketch *D*, which has the advantage of not having the dangerous inner welding seam.

3. All experts agreed that the stay-bolts should be placed as near as possible to the welded joints and not farther than 3 in. from the wall. As to the advisability of reinforcing the stay-bolts and drilling their ends, opinions differ; but it appears advisable to do so, since, in the Dinslaken boiler explosion it was found that six stay-bolts of the lower row had broken before the explosion, while several more had started to crack.

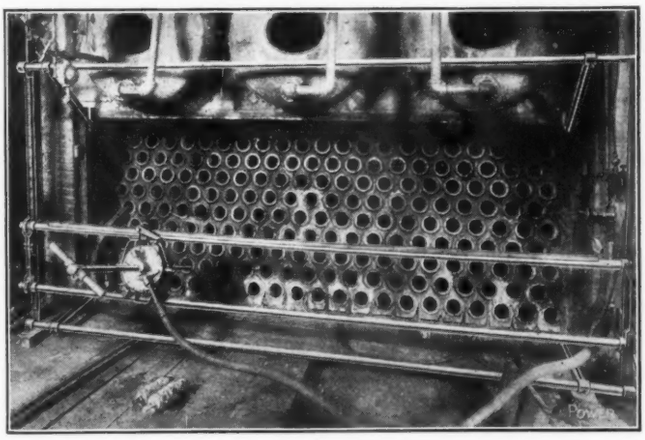
4. The proposal to test the headers at a pressure double that of the operating did not meet with favor. Considerably higher stresses are required to rupture the welded seam so that such a test would not really show much, and it is difficult to make the header water-tight. The high pressure may also start cracks in the header. The advisability of hammering up the seam with heavy hammers during the pressure test was universally recog-

nized as well as the possibility of injuring the seam by too heavy sledges. Tests are to be made to determine this point.

5. The question of annealing the headers after the execution of the welding work was considered; even though the boring of holes and opening in the header relieves the metal to a certain extent from the stresses created by the welding process, this is not complete, and a certain amount of stress remains. When annealed some of the weaker places open up, while other openings can be recognized by the coloration of the metal sheet when cooled.

## A Novel Boiler-Cleaning Arrangement

In the power plant of the Colorado Springs & Interurban Ry. Co., Colorado Springs, Colo., the feed water is exceptionally bad and a very hard scale rapidly accumulates in the boiler tubes. It was impossible to remove this scale economically with any ordinary turbine or self-contained air-driven cleaner. Therefore, in order to expedite boiler-cleaning operations and to greatly decrease the time that a given boiler is kept out of commission for cleaning purposes, this company found it advisable to provide a special boiler-cleaning attachment.



Application of Steam-Motor-Driven Boiler-Tube Cleaner

A Weinland mechanical cutter head is used for removing the scale; it is driven by a Lagonda external steam motor, so designed that the square shaft carrying the cutter head can pass directly through the motor, and while revolving at high speed, can be worked back and forth in the boiler tubes, the motor remaining stationary upon the supporting frame. The motor is supported between rollers at the top and bottom and is given a horizontal motion on the two supporting bars by a small handle at the top of the motor, which turns a pinion operating on a rack on the top supporting bar.

To shift the motor vertically, the two horizontal bars supporting the motor are elevated by pinions operating on vertical racks, these pinions being operated by a crank handle. Both the horizontal and vertical pinions are held in place by pawls, so that after the motor has been adjusted in front of a tube, it remains stationary until the scale has been removed from that tube.

The motor can be driven by either air, steam or water pressure, and with steam at 100-lb. pressure, will develop 7 hp. The shaft supporting the cutter head is sectional and additional lengths are added as the cleaner is worked into the tubes, the handle being attached to the shaft by a swivel joint.

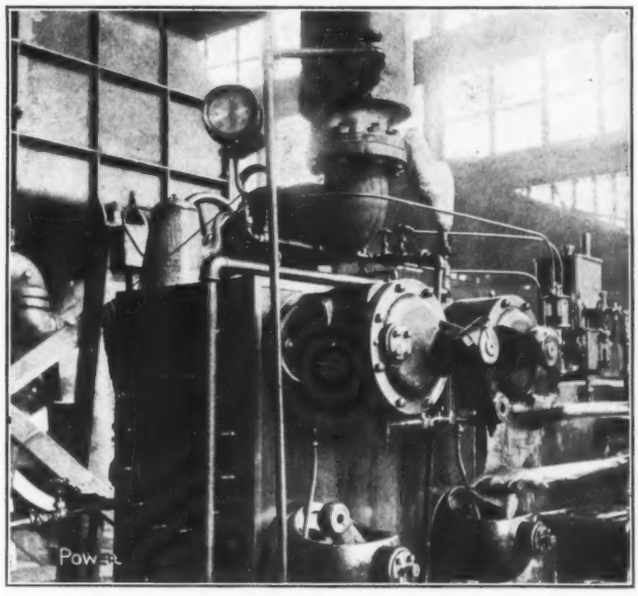
While an equipment such as this would not be recommended under all circumstances, it has, in this case, paid for itself many times over. For instance, C. E. Bibb, chief engineer of the power plant, states that this equipment quickly does the work on scale that was so thick and hard he formerly had to use a small block and tackle to force the cutter head against the scale.

This equipment was designed and installed by one of the engineers of the Lagonda Manufacturing Co., Springfield, Ohio, and has proved so satisfactory where the scale conditions are exceptional that several other similar equipments are being installed.

## Test of Valve and Piston Tightness

A somewhat remarkable photograph is reproduced herewith of an engine running with the cylinder head removed and the head-end valves closed and disconnected from the valve-gear. This photograph has not been retouched and proves that the engine is in operation by the blur of the moving valve-gear parts.

The picture is from the Ball Engine Co., Erie, Penn., and shows one of its Corliss engines undergoing a test for the tightness of its valves and piston. The engine is operating as a single-acting engine, all of the head end being out of commission, and it is plain that no steam is escaping, although it is reported that a few drops of water were discharged intermittently.



Engine Running with Cylinder Head Removed and Head-End Valves Disconnected

It is especially creditable that this is a new engine and not one that has been operated for some time. The manufacturers admit that it is only recently that they have become able to make the valves of new engines so tight. Formerly it was more common to find an engine running better, so far as tightness of valves is concerned, after it had been in service two or three years.

At the time the picture was taken the engine was run-

ning at 220 r.p.m. under a steam pressure of 140 lb. The engine has a 12-in. cylinder and an 18-in. stroke and gives a duty of 20½ lb. per i.hp. per hour at three-quarters load with 140 lb. steam.

❖

# Worthington Rotary Air Pump

By W. Vincent Treeby

The following description is of an interesting condenser auxiliary, a Worthington rotary air pump. Strictly speaking, this name is a misnomer, a more applicable title being hydraulic vacuum pump.

The original Worthington rotary air pump was made

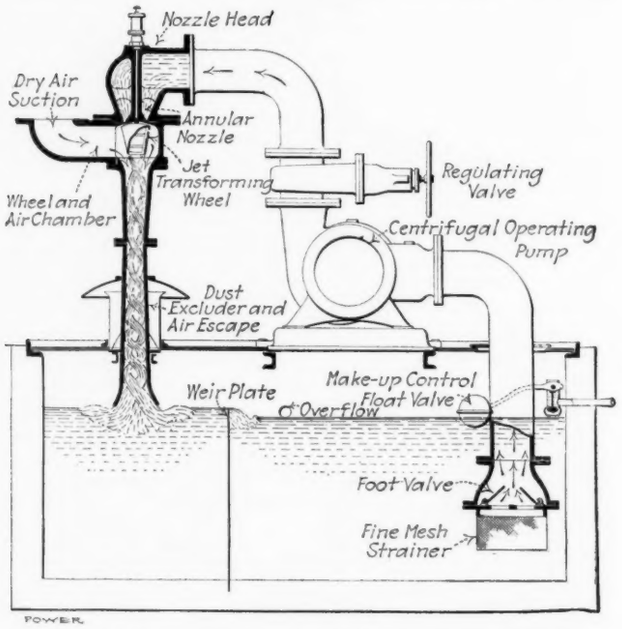



Fig. 1. Illustrating the Operation of the Rotary Air Pump

about two and a half years ago, and has since been in continuous service in connection with a manufacturing power plant, maintaining a mean vacuum of 28 in. on a 30-in. barometer.

The design and construction of this apparatus is exceedingly simple, so much so that its very simplicity has in a way tended to oppose its use. This pump is, in fact, a specially constructed ejector and consists essentially of four parts: The nozzle head, jet-transforming wheel, wheel and air chamber and tail pipe containing the ejector cone and diffuser.

The nozzle head contains an annular nozzle, which is situated in the bottom of the nozzle head. Immediately under the nozzle head is the jet-transforming wheel and air chamber This transforming wheel transforms the annular jet issuing from the annular nozzle into a number of jets of approximately rectangular cross-section. Sufficient space is left between these jets for the entry of air and vapors from the condenser, vacuum pan or other apparatus being exhausted, which is connected up to the side of the wheel chamber. The rotation of the wheel imparts to the jets a rapidly revolving motion and, as a result, the water jets rush through the ejector cone and diffuser in the form of a helix with pitch and velocity diminishing as the compression of the air and vapors goes on. The air and vapors entering around the rotating transforming wheel are promptly caught and inclosed by the issuing water jets, then are gradually compressed on the way down to the tail-pipe discharge. The transforming wheel is carefully balanced and finished with a highly polished inside surface. It is carried on a spindle rotating in ball bearings, which are easily lubricated.

The operating water is delivered to the nozzle head of the air pump by an ordinary centrifugal pump through a regulating valve. After entering the nozzle head, the water flows through the nozzle, wheel and tail pipe, and returns to the operating-pump tank, wherein the contained air is liberated before the operating water is

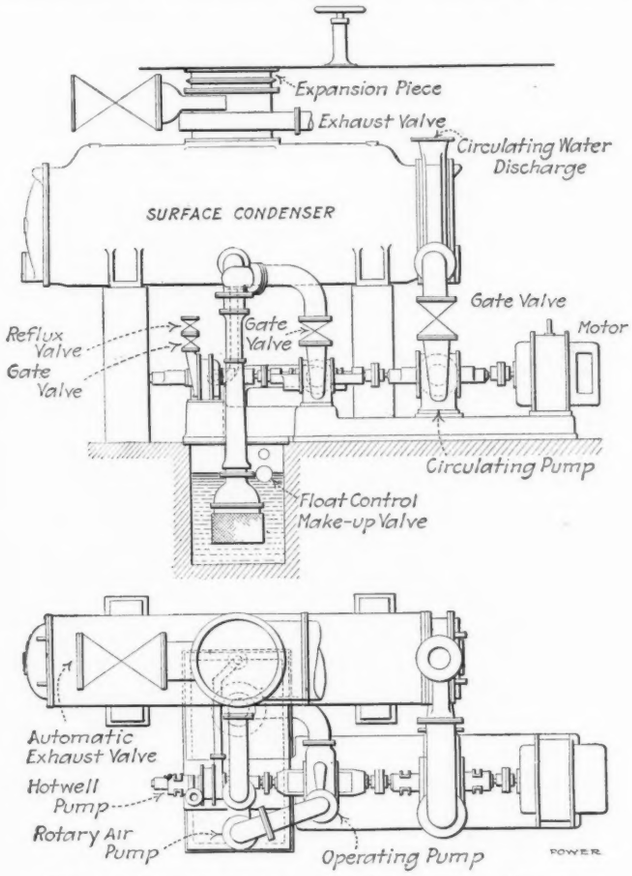



Fig. 2. Application of Air Pump to a Surface Condenser

again picked up by the operating pump and recirculated. After the water leaves the tail pipe it passes over a weir on its return to the operating pump. This weir is provided so as to assist the liberation of entrained air, and it also serves as a ready means of measuring the quantity of water in circulation. Fig. 1 illustrates the operation of this apparatus, and Figs. 2 and 3 show the application of the air pump to a surface condenser and to a low-level jet condenser, respectively.

A study of these diagrams will indicate the relatively small amount of space required for this type of air pump. The operating-pump tank shown arranged under the operating pump may be placed alongside or even above the pump, if the available space is extremely limited, as it will be apparent that the air pump itself may be placed in any convenient position, the connecting pipes being made to suit.

The operating tank is of quite small dimensions, as relatively little operating water is required, the temperature of the latter being more or less independent of the vacuum requirements, owing to what may be called the eductive action of the water jets from the transforming wheel. In order to prevent the temperature of the operating water becoming excessive a small portion is bypassed into the injection supply to the condenser, when convenient, or to waste, a makeup connection, automatically controlled, being arranged on the operating tank. This pump is particularly suitable for a variable load and requires no attention. If the load increases

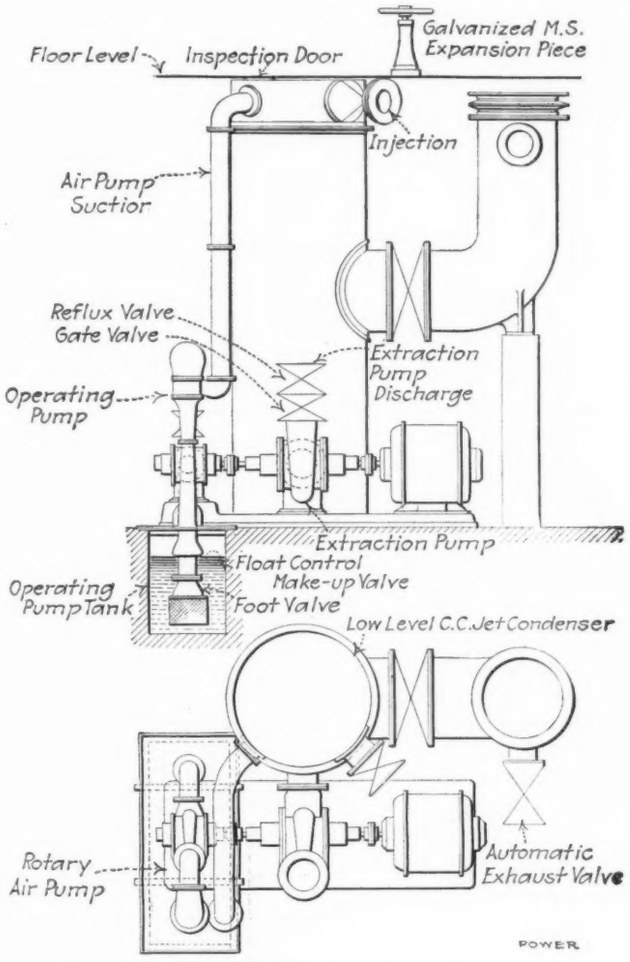



FIG. 3. ROTARY AIR PUMP CONNECTED TO JET CONDENSER

considerably, the vacuum will fall slightly and instantly recover itself on a resumption of normal conditions.

Even if a serious leak should occur, causing the vacuum to fail, it will build up again immediately the leak is removed. This flexibility is because the air pump is independent of the operating pump on the vacuum side. A number of these machines have been installed to handle loads up to 45,000 lb. of steam per hr. with the vacuum ranging from 27.5 to 28.5 in. under guarantee.

❖

At the Newark Bay pumping station (Newark, N. J.) of the Passaic Valley sewerage district, three 100,000,000-gal. submerged centrifugal pumps are to be installed. The pumps will be directly connected to engines, supplied with steam from vertical internally fired boilers. The duty called for is 100,000,000 gal. per hr. against a 37-ft. head or 50,000,000 gal. against a 20-ft. head, and "at all rates between."

# The Frahm Vibration Tachometer

Unlike most tachometers, the Frahm has no gears and is not made to register through outside-rotating connections with the machine on which it is mounted. Instead an application of the principle of resonance is made by rigidly mounting one or more rows of tuned reeds side by side on a common base, Fig. 1. The reeds are made of spring steel about 3 mm. wide with the free ends bent over, as shown in the end elevation.

The instrument is mounted directly to the machine usually by solid iron brackets. Slight vibrations are set

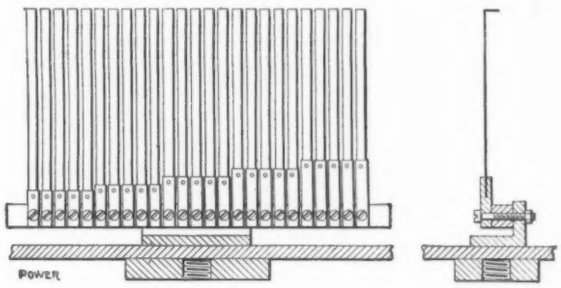



FIG. 1. HOW INDICATING REEDS ARE MOUNTED

up by the revolving element of the machine, which is never perfectly balanced. The number of vibrations depends upon the speed of rotation, and that reed in the instrument which is in tune with the vibrations will vibrate

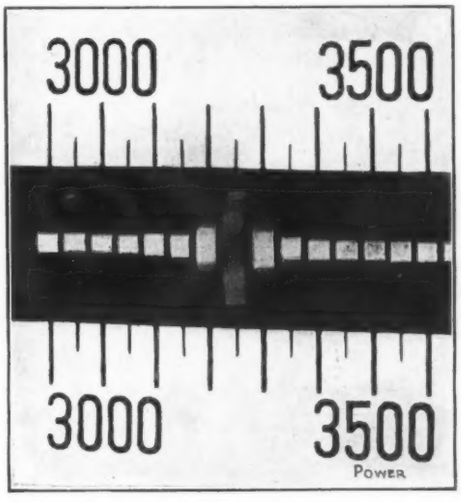



FIG. 2. SHOWING VIBRATION OF REED

through the action of resonance, thereby indicating the revolutions per minute of the machine. If, say, a turbine is making 3000 r.p.m., there will be 3000 impulses and the reed tuned for 3000 impulses will vibrate, thus indicating the speed. The interval between the reeds is usually from 1 to 2 per cent. of the maximum range so as to give accurate readings.

Fig. 2 shows a part of the graduated face of the instrument. Notice the reed indicating a speed of 3250 r.p.m. Fig. 3 shows the appearance of the instrument.

The instrument is best suited for speeds ranging from 900 to 8000 r.p.m., being adapted to turbines, motors, centrifugal pumps, etc. Should the reeds vibrate excessively, a piece of felt should be placed between the machine and the supporting bracket.

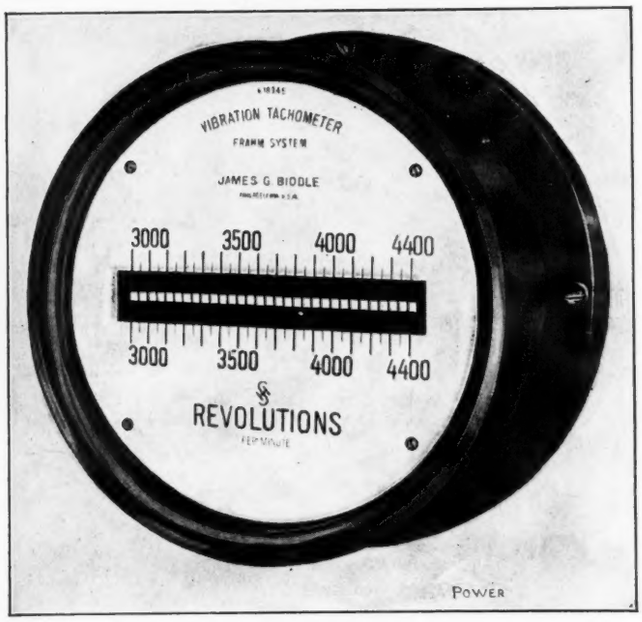



FIG. 3. THE FRAHM VIBRATION TACHOMETER

The vibrations set up by a turbine are indicative of the condition of balance of the rotor. It would seem, therefore, that this instrument would show by the amplitude of the vibration of the reeds whether or not the machine was in normal balance.

The Frahm tachometer is made by Siemens & Halske, Germany. James G. Biddle, 1211 to 1213 Arch St., Philadelphia, is sole agent for the United States.

❖

## New Kroeschell Boiler

The accompanying illustration is of the combination water- and fire-tube boiler recently developed and patented by the Kroeschell Brothers Co., Chicago, Ill., with the idea of combining the advantages of both the water-tube and the horizontal return-tubular boiler.

The boiler consists essentially of a return-tubular boiler to which are attached two water legs; tubes are expanded into these water legs in straight horizontal rows with a downward inclination toward the rear water leg of 1 in. to the foot. Three or four rows of tubes are used, according to the size of the unit. Among the special features are the connection between the front water leg and the shell, and a deflection plate in the bottom of the shell, projecting into the connection between the water leg and shell and extending back about two-thirds of the length of the boiler.

The connection between the front water leg and the main shell is 10 to 12 in. in diameter through which the water flows with a high velocity.

A part of the rapidly moving stream of water entering the drum through the front connection, passes under the deflection plate, preventing any deposit of scale-forming material on the shell or tubes and causing such material to be carried to the sediment chamber in the rear water leg, whence it is readily discharged through the blowoff.

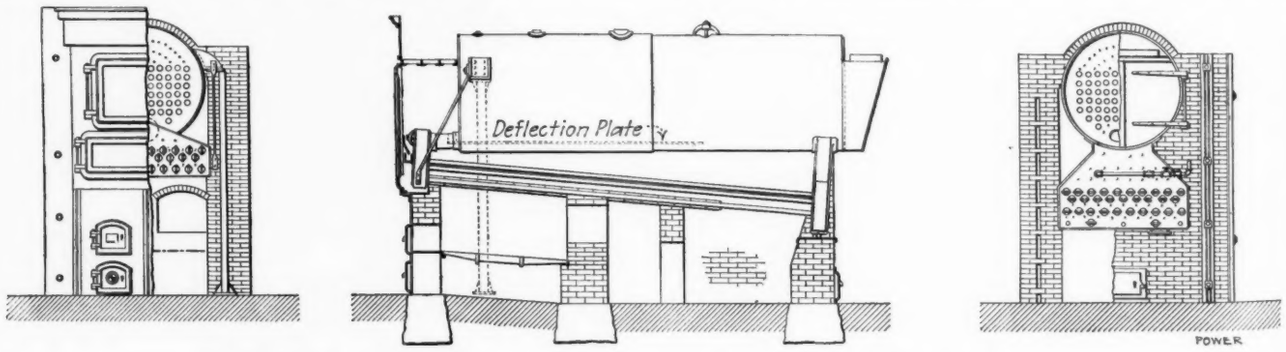
It is claimed that after a run of one of these boilers for four weeks in actual operation, there was found a deposit of less than one pint of sediment in the drum and this had settled on top of the deflection plate near its rear end.

Hollow stay-bolts are used with openings large enough to admit a flue blower, whereby accumulations of soot may be blown off the outside surfaces of the tubes at frequent intervals. A handhole plate is placed opposite each end of each tube for inspection and cleaning.

The furnace baffling is so arranged that the gases of combustion pass around the water tubes and under the shell of the boiler, returning through the fire tubes and passing out of the smoke box at the rear. This arrangement removes the lower half of the shell from the fierce impingement of the fire and still retains it as efficient heating surface. It also prevents unequal expansion and contraction between the tubes and the shell, thus preventing leaky tubes.

On account of the rapid circulation it is also claimed that this boiler gives an efficiency equal to a water-tube boiler as well as a high overload capacity and great flexibility.

Summed up, the points of merit claimed for this boiler are high efficiency; great overload capacity; rapid and positive circulation; self-cleaning of mud and sediment; accessibility; low draft resistance, which means good combustion under ordinary or poor draft conditions; freedom from tube leakage and rapid steaming ability, which makes it well adapted to fluctuating loads.




THE KROESCHELL COMBINATION WATER-TUBE AND FIRE-TUBE BOILER

❖

**Some machines need coaxing; some have to be forced to higher efficiency. Machines act very humanlike at times. A little higher or lower speed may increase the output. I've reduced a machine's speed and increased its average output. Machines must be matched with work and conditions just as men. Sixty warpers in a white-goods mill were operated for years with the creel, instead of the front of the machines toward the light. When they were faced in the opposite direction, the output was increased.—"Factory."**

# ELECTRICAL DEPARTMENT

## Installation and Care of Storage Batteries—II

By H. M. Nichols

### First Charge

The charging current should be ready to turn on as soon as the electrolyte is poured into the cells; otherwise the plates are liable to be injured by sulphating if allowed to stand in the acid without being charged. Have all connections made, cables run, etc., to avoid delay, and never under any circumstances allow the new plates to stand in the acid longer than two hours before beginning the charge. Care must be taken to see that the positive pole of the charging dynamo is connected to the positive pole of the battery as a reversal in connections would ruin the battery.

It is a good plan to test out the generator connections with a direct-current voltmeter and then make them permanent to avoid danger of their being accidentally changed. If at any time repair work is done on the generator or cables leading to the battery board, recheck the polarity, as there is always the possibility of reversal.

The first charge should be carried on for a period of 20 to 30 hours or even longer as this charge is necessary to complete the forming of the plates. The charging may be carried on at the normal rate, provided the temperature of the cells does not go above 100 deg. F. If the temperature goes above this point the charging current must be reduced. It is permissible to charge at a rate lower than normal for a correspondingly longer time if it happens to be more convenient to do so.

The normal rate of charge is usually marked on the cells by the manufacturers, but it may be found by dividing the ampere-hour rating by eight. Thus for a cell the rated capacity of which is 800 amp-hr., the normal charging rate would be 100 amp.

The voltage required at the beginning of the charge will be about two volts per cell and this will rise to a maximum of about 2.6 volts when the cells are fully charged. As the charging nears completion the cells will begin to gas freely, indicating that the plates have taken up nearly all the charge possible and that the surplus current is being used up in decomposing the electrolyte. At this point it is well to decrease the charging current, although moderate gassing does no particular harm other than waste energy.

When the cells are first filled with electrolyte the specific gravity will fall considerably below 1.200, due to absorption by the plates. The specific gravity will rise during the charge until it reaches slightly over 1.200 at full charge. During the ordinary operation of the cells the specific gravity when charged is about 0.025 higher than when discharged.

### General Charging

Always charge at the normal rate or lower except in the case of emergencies. The longest life and highest efficiency is obtained when the battery is charged slowly. During the charge the voltage rises from about 1.8 volts per cell to approximately 2.5 volts when fully charged.

As the battery becomes fully charged, bubbles of gas will be given off freely, which will give the electrolyte the appearance of boiling. Sometimes these bubbles are so fine and numerous that they give the liquid a milky-white appearance. When the battery reaches this stage it is considered fully charged, although it can be made to take up a small additional charge by reducing the strength of the charging current.

The specific gravity of the electrolyte gives another valuable indication of the amount of charge held in the cell, but it is usual practice to depend principally on the voltmeter readings.

If the battery is allowed to remain idle for any length of time, it should be given a charge every week or two to compensate for the loss of charge due to current leakage. If the battery is allowed to stand much longer than two weeks without being freshly charged, there is great danger that the plates will be injured by sulphating.

Trouble is sometimes experienced from excessive acid spray. As the battery becomes nearly charged, the gas bubbles become so numerous that the electrolyte appears to boil and these bubbles breaking at the surface throw a fine spray of acid into the air. This spray corrodes all the metal fittings that it comes in contact with and is also very irritating to breath.

Various remedies have been tried, such as having a film of oil over the electrolyte which does away with the spray, but is objectionable because it sticks to the plates when they are removed, increasing their resistance when they are replaced. Another plan is to put glass covers over the tops of the cells, but they soon collect dust which forms a conducting surface for the leakage of current. The best plan is to reduce the charging current near the end of the charge and depend on good ventilation to remove what fumes are given off.

### Discharging

In ordinary practice a battery is discharged within a few hours after it has been charged. Under these conditions the battery will deliver from 75 to 80 per cent. of the energy put in during charge. In some installations the battery is kept "floating" on the line so that it will take care of any heavy overloads and thus keep the line voltage from fluctuating. In this type of installation the battery carries a considerable percentage of full charge most of the time, as it is likely to be on discharge for only a few minutes at a time and then shift to charge as the load drops, and so on throughout the day.

If the battery is allowed to stand a week before discharging, there will be an additional loss of about 25 per cent. in efficiency.

The discharge rate in amperes is usually the same as the charging rate, which is found by dividing the ampere-hour rating by 8. The battery may be discharged at a

rate considerably greater than the 8-hr. rate for a correspondingly shorter time. In doing this, however, a certain percentage of the capacity in ampere-hours is wasted. For example, a cell whose 8-hr. discharge rate is 50 amp. may be discharged at the rate of 200 amp. for one hour, but in doing this the cell suffers a loss of 50 per cent. in its ampere-hour capacity. Excessive discharge rates are injurious to most forms of cells and should be avoided.

The types of cells that use pasted plates are the most liable to injury from this cause. A battery should never be discharged below a voltage of 1.8 volts per cell, except in the case of heavy discharge for short periods. If the battery is discharged at the one-hour rate, the voltage may be allowed to fall as low as 1.6 volts per cell. If this rule is not observed the cell is very likely to be permanently injured.

Never allow the battery to stand discharged for more than two or three days, as, otherwise, its capacity is likely to be considerably lessened by "sulphating."

### Weekly Inspection

Once a week each cell in the battery should be carefully inspected and tested. With the battery fully charged, measure the voltage of each cell with a low-reading voltmeter. For this purpose a pair of prick-point leads will be found convenient. These are made by soldering a length of flexible cable to a sharp spike which is driven into a wooden handle, the cable being brought out through a hole drilled through the central axis of the handle.

With the battery fully charged also measure the specific gravity of the electrolyte in each cell. In measuring the specific gravity of the electrolyte, use a battery syringe to draw a sample for test from the lower part of the cell, as there is likely to be a slight difference in density between the top and the bottom of the cell. A low specific gravity or low voltage indicates trouble of some kind which should be investigated and corrected at once. If any of the positive plates have a light color it indicates insufficient charge.

Examine the cells for short-circuits both external and internal. When sufficient sediment collects in the bottom of the cells to threaten a short-circuit, siphon off the electrolyte, which may be used again and flush out the cells with clean water.

The electrolyte should be kept at least ½ in. above the tops of the plates. Any electrolyte that is spilled or dissipated by acid spray should be replaced by electrolyte of 1.200 specific gravity. Any loss due to evaporation must be replaced by distilled water. When the cell is fully charged the specific gravity should be about 1.200. If the hydrometer shows a lower figure when the voltage of the cell and the color of the positive plates indicate full charge, dilute acid should be added to bring up the specific gravity to 1.200. Never add strong acid directly to the electrolyte in the cell.

If the specific gravity is too high add pure distilled water to the bottom of the cell with a battery syringe or rubber tube. It is necessary to add the water at the bottom as it is lighter than the electrolyte and if it was added at the top it would not mix well.

A record should be kept of the weekly inspection of the battery so that a comparison can be made from week to week of the action of each individual cell.

A convenient form for this record is given below.

STORAGE BATTERY INSPECTION RECORD

Station———————Date———————

| Cell No. | Volts Open Circuit | Specific Gravity | Remarks |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Always take the record with the battery fully charged and also record the total battery voltage. Under the column headed "remarks," note any peculiar conditions of the cell and also any troubles corrected. Also record any additions of water or acid to the electrolyte to bring its specific gravity to the proper value.

### Locating and Correcting Troubles

The most frequent troubles that occur in storage batteries are short-circuiting, sulphating, flaking, disintegrating of the plates, and buckling or warping of the plates.

### Short-Circuiting

A short-circuit is indicated when the voltage and specific gravity are below normal. The short-circuit may be caused by sediment collecting in the bottom of the cell or by some foreign substance falling into the cell. Cracked insulation may also cause a partial short-circuit.

A cell that has been short-circuited will require more than its usual amount of charge for some little time. This can be accomplished by charging the cell as usual but cutting it out of circuit for several discharges. This method is only practical with small cells that are connected together with bolt connectors. Another plan that does not require the disconnecting of the cell under treatment is to give it an additional charge from an outside source after the battery has been fully charged. Temporary leads can be run to the defective cell for this purpose.

### Sulphating

A cell is said to be sulphated when a whitish scale of lead sulphate forms on the plates. This scale is a nonconductor and thus serves to insulate the active material from the plates. Any indications of sulphating should be corrected at once, for if it is allowed to continue it will not only greatly reduce the capacity of the battery but will also lead to other serious troubles.

Sulphating may be caused by overdischarging, or the battery may be left in a discharged condition for several days, even if the limit of discharge has not been exceeded. If the electrolyte is allowed to get too hot (due to an excessive discharge rate) or if it is too strong the plates are likely to sulphate. A short-circuit may also cause sulphating by discharging the cell below its proper voltage.

A cell that is badly sulphated should have the plates removed and carefully scraped until all traces of the scale have been removed. The cell should then be charged at a low rate (from one-quarter to one-half the normal rate) and only partially discharged. This treatment should be

continued until the sulphating is entirely eliminated and the cell returns to its normal condition.

In some instances it is a good plan to add a small quantity of sodium carbonate to the electrolyte, which will help to dissolve the objectionable scale. After the scale has been removed the electrolyte should be thrown out, and the plates carefully washed to remove all traces of the soda.

### Flaking, Disintegrating and Buckling of the Plates

If the plates are allowed to become badly sulphated, the final result will be that the active material will peel off in large flakes. Buckling is caused by sulphate working in between the active material and the supporting grid. Flaking and buckling are also caused by excessive discharge rates and sometimes by long continued overcharge.

Flaking is objectionable because it reduces the capacity of the cell, due to the loss of active material. Buckling is likely to break up the pellets of active material and cause them to drop out.

Sometimes a plate that has begun to buckle can be straightened by putting it between two soft pine boards and pounding on them gently with a wooden mallet, taking care not to disturb the active material. Positive plates are more likely to be injured from any of these troubles, and it is to them that particular attention should be given.

### Taking the Battery Out of Service

In many installations, such as country residences, summer hotels, etc., the storage battery is allowed to lie idle for a period of several months. In installations of this type the storage battery should be taken out of service at the end of the season.

This is accomplished by first discharging the battery fully at the normal rate, then siphoning the electrolyte into clean carboys for future use, and filling each cell as soon as it is emptied with pure water. When the electrolyte has been replaced with water in all the cells, the battery should be discharged until the voltage falls below one volt per cell with normal current flowing. When this condition is reached the water should be siphoned off. The plates may be left in the cells or they may be removed and packed away for storage. When it is desired to put the battery in service again, proceed as when the battery was first started, giving it an initial charge of from 20 to 30 hr. at the normal rate.

## A New Primary Cell

By Dr. Leonard K. Hirshberg

A. J. Paine, of Wanstead, Eng., has just invented a simple element for generating current that yields 1½ volts for 12 hr. He was in need of a primary cell which, as he put it, would "go one better than the ordinary well known cell," and after making a long search, ultimately came to this combination.

He recognized that chloride of iron had been previously used in cells as depolarizers, but considered no such cells satisfactory either as to capacity or durability. He, therefore, adopted a zinc-carbon excitant with chloride of iron around the carbon and a saturated solution of sodium hyposulphite around the zinc. This gave 1½ volts with a very low resistance. Four cells that each held a quart gave 2 amp. and 6 volts which lasted 11¾ hr. when a slight decrease in current began. The current remained constant as long as the chloride of iron was saturated.

The carbons can be made of a gridiron series of plates with lumps of the iron chloride on top. Plain zinc is better than analgamated zinc. If a black scum forms after 11 hr., a little running water will remove it. There is no odor at all to the Paine cell. Hyposulphite of soda is twice as efficient, according to the inventor, as zinc sulphate or other zinc solutions.

## Troubles with a Second-Hand Dynamo

Buying second-hand electrical machinery is largely a gamble. In the present instance a four-pole, 25-kw., 110-volt dynamo was purchased from a reliable dealer on a guarantee to be in good running order and to develop the rated load when running at 625 r.p.m.

The machine was set up and started, but would not show more than four volts by the voltmeter. Short-circuiting the armature would only raise the voltage temporarily, its value dropping back as soon as the short-circuit was removed.

A careful examination of the machine and the armature winding showed the direction of rotation to be right, but it was almost impossible, owing to the taped insulation to tell the direction of the shunt-coil winding.

There were no marks to indicate which were the positive or negative terminals and the position of the brushes was all one had as a guide. After tracing the winding it was discovered that the wires leading to the rheostat were both connected to the same side.

To rectify this mistake, which had made the magnetizing effect of the shunt coil almost nil, one wire was changed to the opposite side which made the shunt coil active, and the machine immediately built up the voltage, but would not carry more than half load without lowering the voltage. This was due to the fact that the shunt-field coil and the series coil were opposing one another. The series coil was a very small one and its effect on light loads was not appreciable, but when heavy loads came on, its effect was greater and the heavier the load the less the voltage. Suspecting this to be the cause of the low voltage as soon as it was possible to stop the machine, I shifted the leads of the series coil. This left the electromotive force flowing through both the series and shunt coils in the same direction and the machine then held up the voltage as required.

R. A. Cultra.

Cambridge, Mass.

**The quantity of coal required to produce a ton of coke is much less than formerly. The average gain in 1912 compared with 10 years ago is probably at least 160 pounds. It is doubtful if in the earlier years the actual yield of coal in coke exceeded 60 per cent. whereas in 1912 it was 67 per cent., according to the United States Geological Survey. This gain is largely due to the increase in the production of by-product coke, in which the yield of coke from a ton of coal is very much higher than in making beehive coke. In Illinois, Indiana, Massachusetts, Michigan, New Jersey, New York, and Wisconsin, where coke is made exclusively in by-product plants, the yield varies from 69.6 per cent. (in Wisconsin) to 81.8 per cent. (in Indiana), whereas in the States where beehive practice prevails the yield in 1912 varied from 50 per cent. (in Georgia) to 66.5 per cent. (in Pennsylvania).**

# GAS POWER DEPARTMENT

## The Big Ford Gas Engine

By F. R. Low

When the ordinary man lays out a manufacturing establishment he puts the power plant in the back yard if not in the cellar. Henry Ford is not an ordinary man, and when he built the Ford works in Detroit he put the power plant in a glass case and set it out upon the sidewalk. Fig. 1 shows how it looks to the passerby on busy Woodward Ave.

FIG. 1. POWER HOUSE FROM STREET

For an ordinary plant the ordinary man would have selected the "safe and sane" steam engine. When the Ford plant was built the producer-gas engine was at the front in the power field, and Ford adopted it and has held to it through all the vicissitudes which have assailed the big gas-engine business. When the company from which the first engine was bought was unable to carry out its contract he completed it himself. With that engine he got Edward Gray, and whether they made the engine go where so many have failed may be judged from the fact that they are today installing, built to Mr. Gray's design, the most powerful producer-gas engine yet built in any country.

The first unit installed was a 35x48-in., two-cylinder tandem running at 100 r.p.m. It drives an 850-kw. Western Electric generator and a 2000-cu.ft. air compressor, to which it is cross-connected, and develops only about one-quarter of the power which the works at present demand. Fig. 2 shows this unit, which is of the Riverside type, described in detail in our issue of May 5, 1908.

The building, originally large enough to accommodate this unit only, has been extended to receive the new large engine, photographs of which are reproduced in Figs. 3 and 4. It was built at Hamilton, Ohio, by the Hooven,

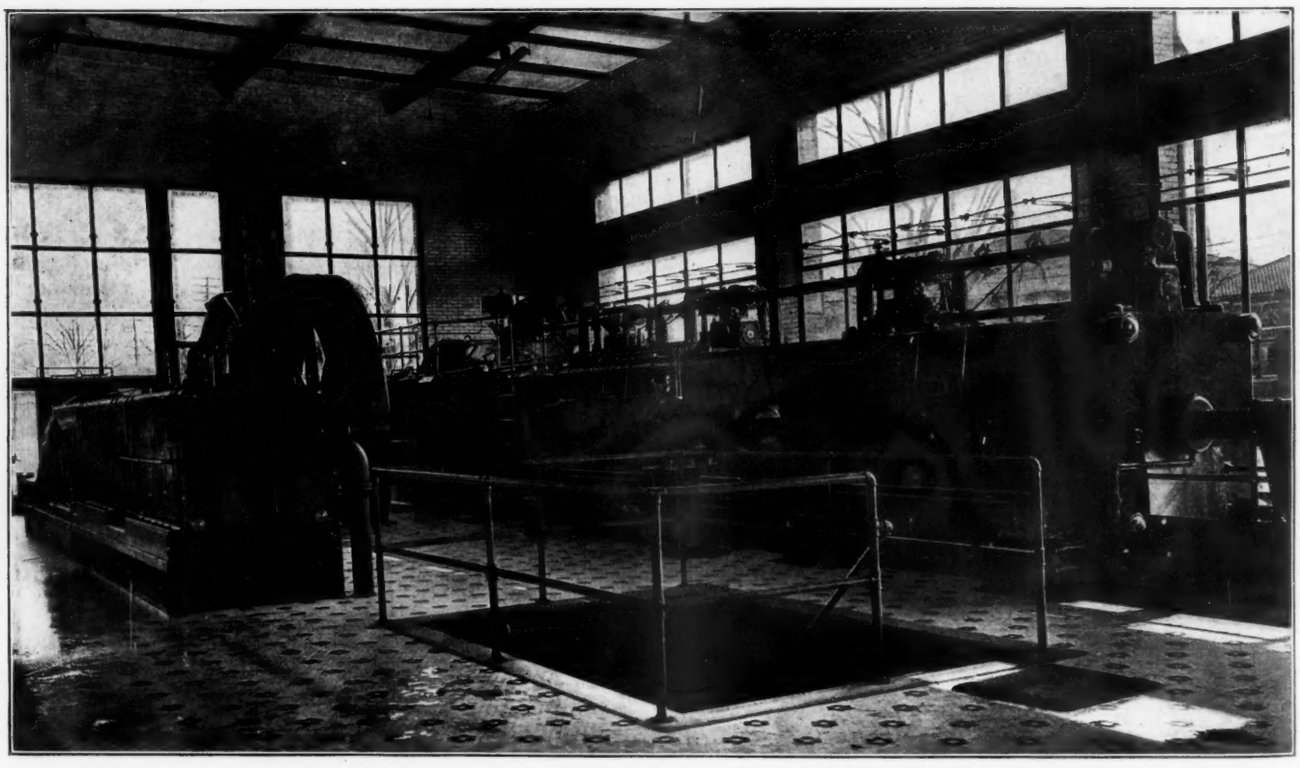


FIG. 2. GENERAL VIEW OF SMALLER ENGINE

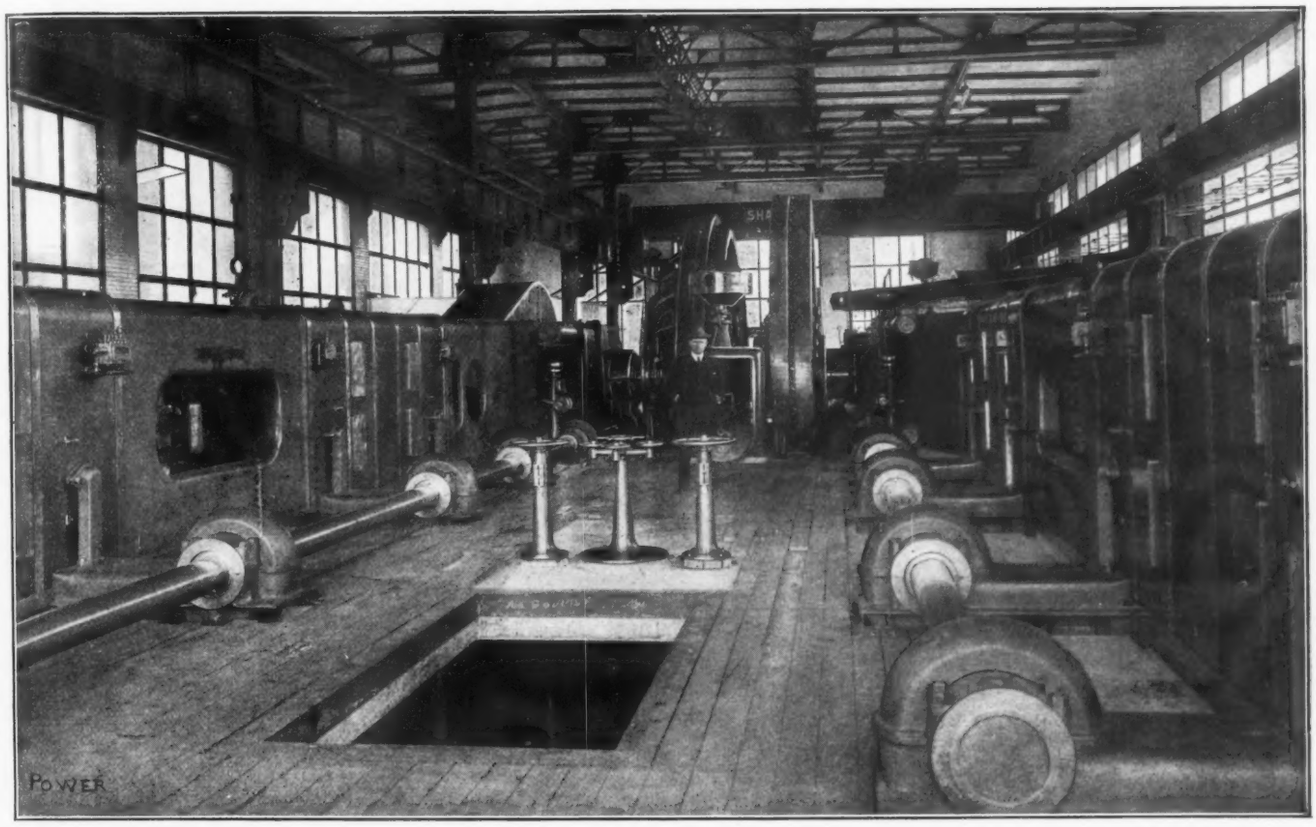



FIG. 3. BIG FORD ENGINE FROM HEAD END

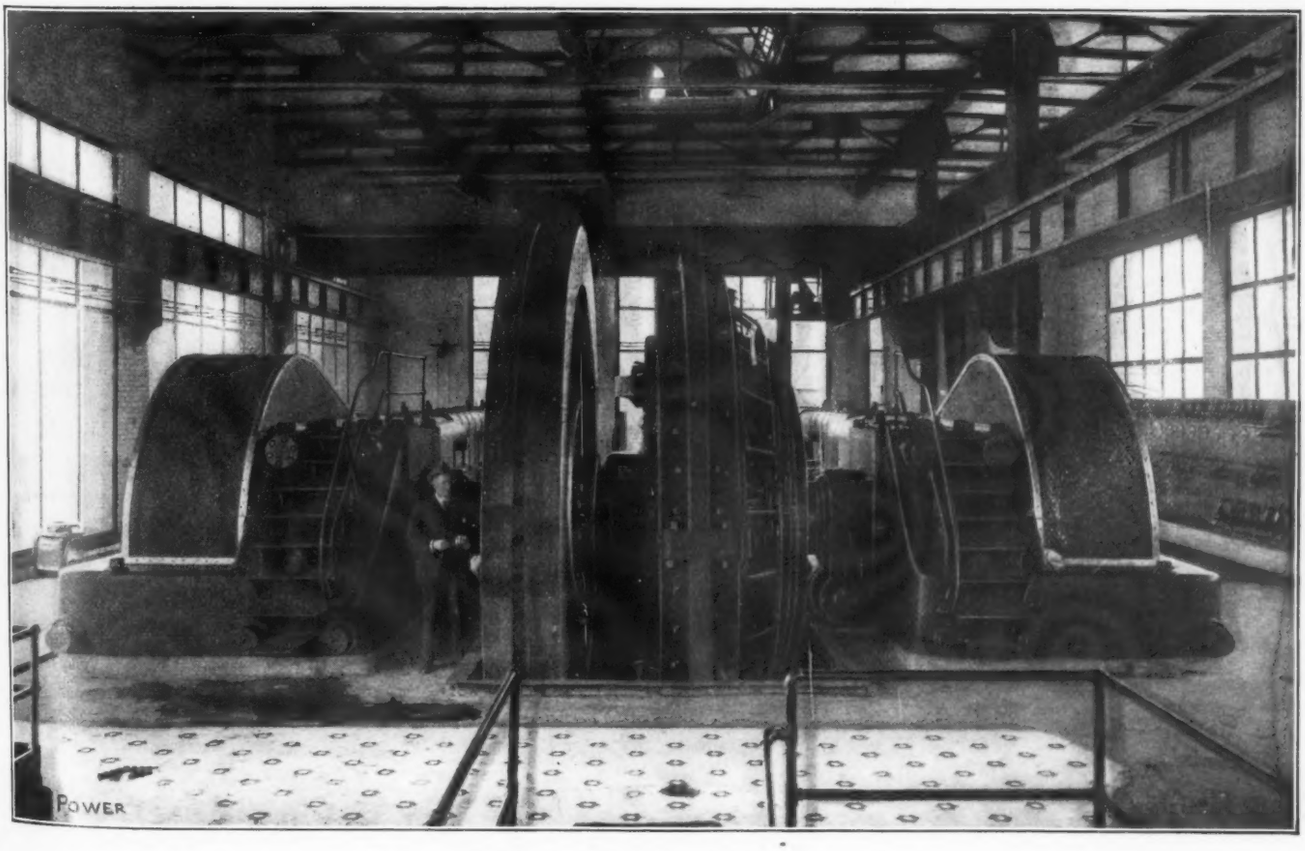



FIG. 4. BIG FORD ENGINE FROM GENERATOR END

Owens, Rentschler Co., and we hope in a future issue to be able to describe it more in detail.

The engine casting is designed symmetrically around the center line. There is no massive bedplate. The motive of the designer was not to bind his engine together in great masses and then torture them with conflicting stresses, due in part to their own massiveness, but to hold the cylinders in line upon an ample foundation with freedom to come and go under stress and temperature, and with plenty of metal to take the working stress and to rigidly preserve alignment and relative position where they are essential. The weight is, therefore, carried directly by the foundation with light sole plates and guides at the places where movement will take place.

This is a one-story and basement engine, and the valve-gear is all in the basement; see Fig. 6. There are four double-acting cylinders, 42x72 in., two in tandem upon each side, held together with four 6-in. tie-bolts. The engine is designed to run at 85 r.p.m., or 1020 ft. of piston speed. There have been gas-engine cylinders of greater diameter, but this length of stroke and piston

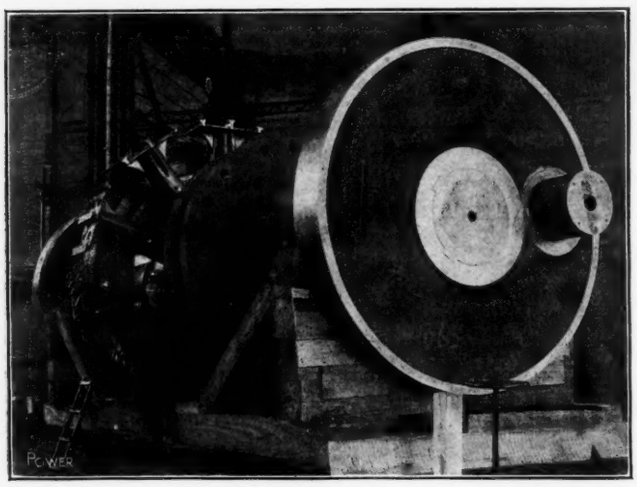



FIG. 5. CRANKSHAFT AND CRANK

speed give, we think, the greatest displacement that has yet been attained per cylinder.

The length of the engine from the front of the pillow block to the end of the tail-rod extension is 73 ft. and its overall width is 32 ft. The crankshaft (Fig. 5) is 32 in. in diameter, 25 ft. long, carrying an 80-ton flywheel and a 2500-kw. generator armature, and the connecting rods weigh 10,300 lb. each. The generator is capable of carrying a 25 per cent. overload, and the engine has a capacity of 5000 i.hp.

The layshafts are driven by bronze worms upon the main shaft, and are divided by pin couplings, so that as expansion takes place, each section remains with its particular cylinder and the crank *R* preserves its alignment with the rocker-arm *A*, Fig. 7, which it drives. Each layshaft carries four cranks, one for each end of each cylinder, and each crank operates both the inlet and the exhaust valve of the end which it serves.

Both of these valves are of the mushroom type and are located in the pockets in the bottom of the cylinder. The exhaust port is visible in the bottom of the cylinder, Fig. 6. The crank rod takes hold of the rocker-arm, which is connected by a right and left connection to the exhaust-valve wiper *B*. This is shown in its active position in Fig. 6. In this position a small movement of the rocking lever will produce a considerable movement of the wiper and communicate a quick movement to the valve, while in Fig. 7 the wiper is shown in its position of dwell

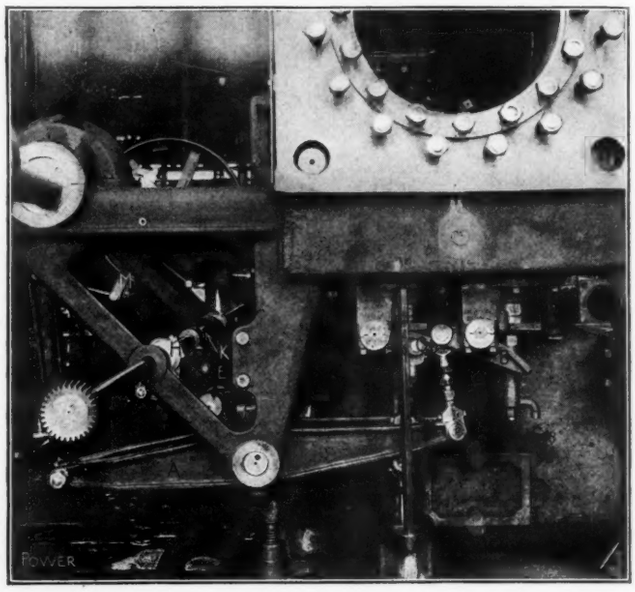



FIG. 6. VALVE-GEAR WITH EXHAUST VALVE JUST BEING RAISED

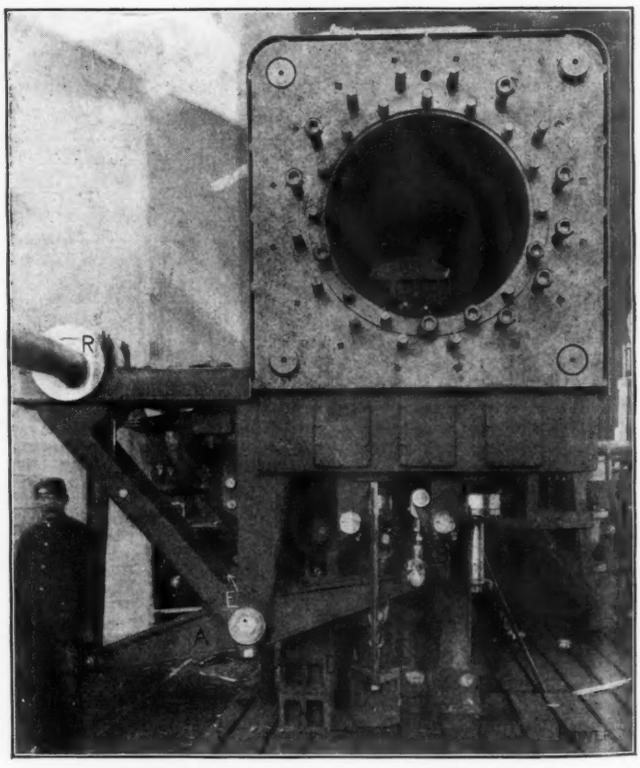



FIG. 7. VALVE-GEAR WITH EXHAUST-VALVE WIPER IN POSITION OF DWELL

where the rocker-arm, and especially the crank, which is near the bottom of its throw, can move through a considerable arc without moving the valve.

It will be noticed that the rocker-arm or beam is double, and that the connections are through pins, with

no overhung bearings, a principle which is carried throughout the design.

The admission valve is actuated by a wiper *C* driven by the lever *D* (Fig. 7), carried between the arms of the beam and pivoted at the center. The hook *E* carried upon a lever pivoted in lugs upon the rocker-arm, engages with a similar block upon the arm *F* (Fig. 6) which forms a bell crank with the lever *D*, lifting that lever and with it the wiper *C*, which actuates the inlet valve. A cam, the position of which is controlled by the eccentric *H* upon the governor shaft *K*, trips the valve at a point in the stroke determined by the governor, just as the steam valve upon a Corliss engine is tripped, and the valve is closed by a spring (not shown) and cushioned by the cushion pot *L*. The governing is thus by the quantitative method, and the governor, which is of the Jahns type, has no other work to perform than to adjust one position of the tripping cams. Motion is taken off from the crank rod by the lever *M* for the positive feed lubricators. The entire gear is direct-acting, simple and accessible.

Water for cooling the pistons is taken in at the crosshead between the two cylinders through the telescopic rod *R* (Fig. 8). The lower end is pivoted below the engine and the rod oscillates with the crosshead. The piston rod contains an inner tube through which the water passes to the piston; on the return it passes outside this inner tube and thus raises the temperature of the incoming water.

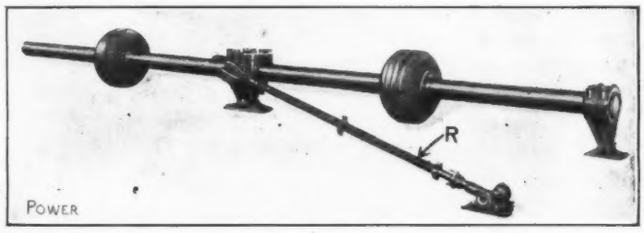



FIG. 8. ARRANGEMENT FOR SUPPLYING WATER TO PISTONS

## Silencer for Large Engines

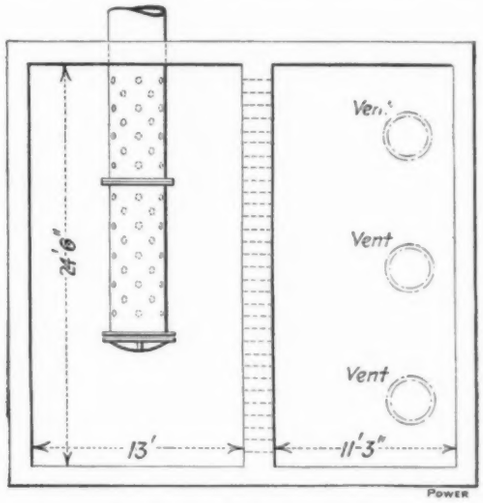
In a large engineering works where gas generated from bituminous coal was the motive power, the silencer here described was constructed for one of the power houses to handle the exhaust gases from engines of a total of 2500 hp., although at first only one engine of 1000 hp. was installed.

The silencer was built just outside the power house, and consists of a brick-lined pit divided into two chambers, as shown in the sketch, which is a plan view with the top removed. This top consists of I-beams, between which is cement, supported by wrought-iron plates resting on the lower flanges of the I-beams. There also are manholes for the two chambers.

The chamber into which the exhaust pipe enters is 13 ft. wide, 24 ft. 6 in. long and 7 ft. 6 in. deep, with a volume of 2389 cu.ft. This is separated from the second chamber by a perforated brick wall. The second chamber is 11 ft. 3 in. wide, 24 ft. 6 in. long and 7 ft. 6 in. deep, with a volume of 2067 cu.ft.

The cast-iron exhaust pipe entering the first chamber is close to the ground, and has an internal diameter of 3 ft. 4½ in., giving an area of 1288.2 sq.in. The lower half of the pipe is perforated, the first length by 2¼-in. holes, pitched 8 in. from one another in lines parallel to the center line of the pipe, and staggered from the next row, the rows being spaced 4⅝ in. apart. The area of the perforations in this length is 1119 sq.in. The second length of pipe is perforated by 2⅜-in. holes similarly spaced, giving an area of 1230 sq.in. At the outlet end of the pipe is a blank flange.

On the top of the second chamber are three steel vent stacks, each 3 ft. 1¼ in. internal diameter and 55 ft. high. The exhaust gases after leaving the engine pass through a water heater, or when the heater is cut out, through a grid of iron plates played on by a spray of water, before entering the silencer.




PLAN OF EXHAUST PIT

G. MOORE.

Newark, N. J.

## Another Hamburg-American Liner with Diesel Engines

From the shipyard of Blohm & Voss, Hamburg, has been launched the motor cargo vessel "Kurmark" for the Hamburg-American Line. This vessel is of 7500 tons gross displacement and will be provided with two single-acting, four-cylinder, two-stroke cycle, Diesel engines developing a total of 2700 b.hp.

Two four-cylinder, four-stroke-cycle auxiliary engines, each driving a dynamo, are provided; one of the engines also drives an injection air compressor, and the other a manœuvring air compressor. The compressors can be disconnected. A small two-cylinder set, driving a dynamo and an auxiliary compressor, serves as a standby. When at sea the main engines themselves effect the operations necessary for their working. One of the four-cylinder auxiliary sets supplies, when running at a moderate speed (about 250 r.p.m.), the electricity for lighting the interior of the ship and for driving the steering gear, ballast pumps, lathe and reserve auxiliary pump. The other auxiliary engine forms a reserve. Cooling-water pumps, bilge pumps, etc., are driven from the main engines. The small reserve set generates the current for lighting when in port.—*Der Oelmotor.*

# REFRIGERATION DEPARTMENT

## Causes for Variation in Quality of Distilled-Water Ice

By Peter Neff

It is apparent to all that there is a great variety in the quality of distilled-water ice, some plants produce a superior grade while others in the same locality do not. Why this is so may be due to a multitude of causes. There are, however, several simple ones which to a greater or less degree affect the quality, and some of these will be considered.

If pure distilled water could be placed in the cans, the ice would be practically clear and of a uniform quality. This condition cannot be realized in practice and all that can be hoped for is to approximate the ideal condition as nearly as possible.

Air in the water is an ever present trouble. If it has not gotten into the water before, it will when the can is being filled. The amount will vary with different tank men, because intentionally or otherwise, one man will so place the can and filler that a minimum amount of water will seal the end of the filler. Where the storage tank is placed so high above the top of the ice tank that there is considerable pressure at the filler, the inrush of the water to the can when the filler is opened will cause a large amount of air to be taken up by the water. This can be avoided by choking the flow to the can-filler hose.

A frequent source of air introduction is produced by draining the storage tank so low that the outlet is exposed, or so nearly so as to cause a suction of the air. There are times when the packing about the stem of the can-filler valve is not tight. When not in use a small leak may be observed at this point, which usually disappears when the filler is put into service, for the water in passing this opening will cause air to be drawn in.

The most fruitful source of air is the flat cooler, and sometimes the filter as well, when located above the storage tank. In such an arrangement there is a tendency at all times to suck in air through small leaks about the valve stems and joints. By putting water pressure on this part of the apparatus, the leaks may be located. All parts of the distilling system from the reboiler or skimmer to the storage tank should at all times be full of water under pressure.

Where the condition noted prevails, a regulating valve controlled from the reboiler or skimmer should be placed at a point below the bottom of the storage tank. And the opening through this regulator should not be so great as to allow the water to flow through faster than supplied from the reboiler or skimmer, for if it does it will produce a suction on the apparatus between the regulator and the reboiler.

Care must always be exercised to see that the reboiler is not allowed to drain, for when it does enough air is introduced to ruin all the water in the storage tank and in some cases to cause parts of the apparatus to become air-bound. The surest method is to have the flat cooler and filter below the bottom of the storage tank, which will insure their being full of water at all times, but even then it is desirable to have the regulator below the storage tank.

A little care in these particulars, remembering that falling water will suck in air when passing a small opening, will reduce air troubles to a minimum.

Air in the water is manifested in the ice by a white core with radiating needles. But air is not the only cause of white ice. Other gases generated in the boiler from impurities contained in the water used, pass with the steam and are taken up by the water when condensation takes place. Some of these gases have a disagreeable odor, so often noticeable in manufactured ice. A proper venting of the steam condenser will help to get rid of these gases. In other words, allow a small amount of steam to escape from the condenser at all times.

The object of the reboiler is to further eliminate these gases as well as the air, and for that reason the reboiler does better work when the depth of the water is small in comparison with the area of the water surface, so that the gases have a freer exit. In spite of these precautions some gas will remain in the water, and for this reason it is customary to filter the water through charcoal, taking advantage of its peculiar property to retain or occlude them. The capacity of charcoal for this purpose is limited, especially when some oil is passing with the water, as the oil tends to fill up the small interstices in the charcoal. When care is not exercised to thoroughly eliminate these gases in the condenser and reboiler, it is but a short time before the charcoal filter is of no use, although to the eye the charcoal may appear all right.

Of all these gases the principal source is the foreign matter contained in the water used in the boiler. Some gas may come from the oil used, but the greater quantity comes from the water. As the process of concentration goes on in the boiler, more of these gases are driven off, and the higher the temperature of the steam, corresponding to a higher pressure, the more readily will the gases be formed. To obviate this trouble, the boilers should be blown down frequently, and the steam pressure carried no higher than is necessary for the work and supply only the requisite amount of distilled water.

There is another trouble causing white cores and sometimes a white or cloudy appearance of the outside of the cake of ice, with clear ice lying just under it. This trouble also comes from impurities in the water used in the boiler. More or less water is carried along with the steam, and if the boiler is priming the quantity may be considerable. When this raw water contains certain impurities, they crystalize at the same time as the ice crystals are formed, and produce the cloudy appearance referred to, which is easily distinguished from the white ice produced by air. Other impurities concentrate in the center of the ice cake and go to make up the white core. A separator on the main steam line will help eliminate this trouble, which is also lessened by the frequent blowing down of the boiler.

There is the question of iron rust from the interior of the apparatus, the troubles caused by the presence of oil, dirt and bacteria, and sometimes raw water getting into the ice can from the fact that the cans after being in a dip tank are not drained. This trouble has been one of the reasons why can dumps that return the can to an upright position as soon as the ice goes out, have not been popular. To guard against these troubles, as well as many others in different parts of a plant, is the daily consideration of a good engineer. It is a fight all the time and success will come only to the engineer who will use his head, and is quick to detect small irregularities in the operation of the plant.

## Operating on the Flooded System

By R. L. Mossman

Some of the advantages of the flooded system over the expansion evaporating system will be mentioned for the benefit of engineers who have not handled both. The flooded system is used to supply each and every coil in the freezing tanks with a proper supply of liquid ammonia. The distribution of the liquid is practically automatic, due to the head of the liquid carried in the accumulator above the brine-cooling coils. To properly regulate the supply of liquid to each coil is more difficult when the expansion evaporating system is used for the reason that it is hard to tell which coil is getting too much and which

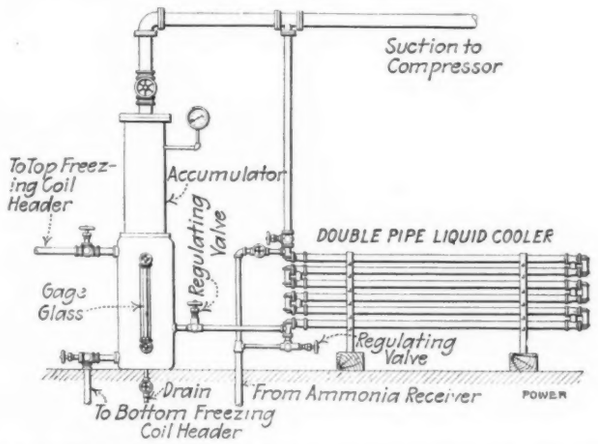



Fig. 1. Flooded System with Double-Pipe Forecooler

is getting too little liquid. In a plate ice-making system the necessary supply of ammonia to each plate becomes less as the thickness of the ice increases, making it necessary when separate expansion valves are used for each plate, to adjust the regulating valve frequently. The flooded system takes care of this variation automatically.

To get the best efficiency in the operation of cooling coils their internal surfaces should be kept wet by the liquid at all times. The pipes which are filled with vapor do very little work. The flow of heat from the brine is much greater when there is liquid than when there is gas on the inside of the pipes. The truth of this statement can be verified by observing the evaporation of a sample of ammonia in a test tube. No ice will be formed on the outside of the tube above the surface which is wetted by the liquid. A similar action takes place in the coils of the freezing tank.

In the flooded system liquid ammonia is fed into the bottom of the coils, and passes up through them to the accumulator from which it started. Here the vapor that has been formed is separated from the liquid, the vapor going to the suction of the compressor, while the liquid mixes with the fresh liquid introduced into the accumulator.

In the direct-expansion system the liquid ammonia is fed directly into the evaporating coils, and must be cooled

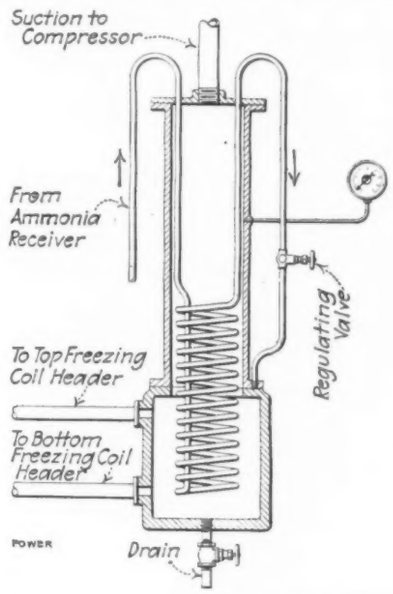



Fig. 2. Accumulator with Cooling Coil Inside

down to the temperature due to the pressure within the system before it can refrigerate the brine. This work of cooling down the liquid ammonia usually requires the evaporation of about 15 per cent. of the total liquid fed into the system. In the flooded system this work is done in the accumulator, the gas liberated going to the compressor while the liquid enters the coils.

While on this subject it will be well to mention that the practice in some plants of placing the ammonia receiver in the engine room or some other hot place should be condemned. The receiver should be placed in as cool a place as possible. Otherwise, if it is subjected to a temperature higher than the temperature due to the condensing pressure, it will absorb heat and some of it will evaporate and force vapor back to the condenser. Every 5 deg. that the liquid ammonia is cooled before it reaches the regulating valves means a reduction of about 1 per cent. in the work to be done by the compressor.

As an example, if the condensing pressure is 183 lb., the temperature of the liquid ammonia leaving the condenser will be about 90 deg. If the liquid is cooled down to 60 deg. by cooling water of about 54 to 56 deg., this reduction of 30 deg. in the temperature of the liquid before it reaches the regulating valve, means that the amount of ammonia that the compressor must handle to produce a ton of ice will be reduced 6 per cent. The capacity of the refrigerating machines for manufacturing ice will be increased one ton in every 17 tons.

Figs. 1, 2 and 3 show some of the accumulators and their connections that are in use with the flooded system. Fig. 1 shows the connections for a flooded system where a cooler is used to cool the liquid ammonia before it enters the accumulator. The ammonia from the re-

ceiver enters the inside pipe of the double-pipe cooler at the top and flows out at the bottom into the accumulator and out of the lower connection of the accumulator to the freezing coils, returning through the upper connection. The liquid is retained in the accumulator while the vapor goes to the suction of the compressor. The height of the liquid should be kept between the top and bottom connections. The liquid is cooled in the double-pipe apparatus by operating the regulating valve at the bottom of the cooler. The gas from the cooler is piped into the suction line as shown.

Fig. 2 shows a type of accumulator with a liquid fore-cooling coil inside. The liquid ammonia from the receiver passed through this coil and is cooled by the surrounding liquid and saturated vapor.

Fig. 3 shows another type of accumulator. Here the liquid ammonia enters the bottom of the freezing coils direct from the receiver or liquid cooler, if one is used. The amount of liquid carried in the accumulator should be from 18 to 24 in., the height of the liquid being indicated by the frost on the small indicator pipe shown. The valve *A* at the top of the pipe should be only partly opened, just enough to equalize the pressure, for if it is opened too wide there may be enough expansion in the pipe to cause the frost line to show higher than the liquid

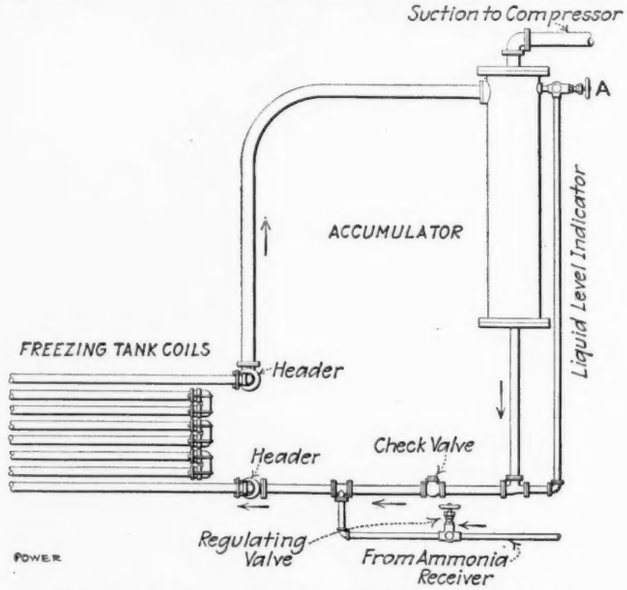



FIG. 3. FLOODED SYSTEM IN WHICH AMMONIA FIRST ENTERS TANK COILS

level in the accumulator. As may be noticed there is a check valve on the bottom connection from the accumulator to the freezing coils to prevent any vapor from returning against the flow of liquid. All of the vapor has to pass out through the top connection of the coils.

In the flooded system the accumulator must always be placed higher than the freezing coils to give a head to the liquid, and all pipe lines slope toward the coils.

The following data show the approximate amount of ammonia required for different-sized plants using the direct-expansion and flooded systems:

| Capacity, ice making, tons | Ammonia for direct-expansion system, lb. | Ammonia for flooded system, lb. |
|---|---|---|
| 10 | 400 | 700 |
| 15 | 500 | 800 |
| 20 | 600 | 1100 |
| 30 | 900 | 1500 |
| 40 | 1200 | 2000 |
| 50 | 1500 | 2500 |

When the capacity of the plant is over 50 tons, the amount of ammonia required will be in direct proportion. For example, 100 tons would require 3000 and 5000 lb. of ammonia respectively. It would be possible to use less ammonia than the weights given.

## Dead Ammonia

One of our readers recently asked if there was such a thing as dead ammonia and how it would act in a direct-expansion system. As there may be others who are not familiar with this term, we are publishing the answer as a matter of general interest.

The term "dead ammonia" is frequently applied to anhydrous ammonia that has become contaminated by refrigerating oil or perhaps water drawn into the system. The effect of these impurities is to raise the boiling point of the ammonia so that it is sluggish in evaporating out of the impurities at the usual back pressure.

By drawing a sample of such impure ammonia from a pipe coil or storage tank it will be found that when evaporation ceases the impurities will have deposited in the vessel used for the purpose. This is a good way to determine how much the ammonia has been adulterated.

There are, of course, ammonia purifiers on the market into which the impure liquids, generally found at the bottom of the receiver, are drawn. By means of a small amount of steam this liquid can be heated and the anhydrous ammonia returned into the suction line. The impurities are collected in the purifier and may be blown off. Another type of purifier not only takes the liquid from the receiver but also purifies the suction gas before it enters the compressor. Both systems are useful in connection with refrigerating and ice-making plants as they will eliminate the so called dead ammonia.

## Cold-Storage Temperatures

The following cold-storage temperatures for different classes of goods were given by the committee on refrigeration of the National Electric Light Association:

| | Deg. F. | Specific Heat |
|---|---|---|
| Beef (fresh) | 36–40 | 0.68 |
| Hogs | 29–32 | 0.51 |
| Lamb and mutton | 32–36 | 0.67 |
| Veal | 34–36 | 0.70 |
| Meats (in pickle or brine) | 35–40 | 0.54–0.58 |
| Butter | 0–38 | 0.64 |
| Eggs | 29–32 | 0.76 |
| Cheese | 32–34 | 0.64 |
| Lard | 38–40 | .... |
| Poultry (to freeze) | 5–10 | 0.78 |
| Poultry (when frozen) | 25–28 | .... |
| Game (to freeze) | 5–10 | 0.80 |
| Game (when frozen) | 25–28 | .... |
| Fish | 25–28 | 0.82 |
| Oysters | 33–45 | 0.84 |
| Beer | 33–42 | 0.90 |
| Wines | 40–45 | 0.90 |
| Cider | 30–40 | 0.90 |
| Fruits | 33–36 | 0.92 |
| Vegetables | 34–40 | 0.91 |
| Canned goods | 38–40 | .... |
| Flour and meal | 40 | .... |
| Furs | 25–32 | .... |
| Brine for ice cream freezing | 5–10 | .... |
| Ice cream (air hardening) | 5 | .... |
| Ice cream (serving temperature) | 14–16 | .... |

Mechanical refrigeration as applied to cooling water and milk usually has one feature different from other classes of refrigerating work. A large quantity of cooling effect is called for in a brief interval of time. For instance, in a drinking-water system the heaviest requirements may come at the noon hour. In dairy work the milk must be cooled rapidly to check the development of bacteria.

# EDITORIALS

## Large Units

The present is often referred to as an age of big things. Not only does each year bring forth taller buildings and steamships of more gigantic proportions, but in the power field the same tendency prevails—the adoption of large units.

Elsewhere in this issue are illustrated a few of the largest units of their kind. This list is by no means complete, for it does not include the big Delray boilers nor the thirty-five thousand-horsepower turbine which is nearing completion for the Commonwealth Edison Company of Chicago.

When such large units were first laid down there were many engineers who questioned their feasibility, both from an operative and an economic standpoint; in short, they did not believe in putting too many eggs in one basket. These fears have been discredited, however, by the subsequent performance of these large units; not only have they shown exceptional economy, but their operation appears to be entirely satisfactory. In fact, the Detroit Edison Co. was so well satisfied with the large Stirling boilers that it is increasing the number to nine at its Delray station, and the New York Edison Co. appears to have signified its approval of the twenty thousand-kilowatt turbines installed at the Waterside station by putting in still larger ones at its new station at Two Hundred and First Street.

In the gas-power field the big Ford engine, described on page 128, marks the present limit in size. How far this will be exceeded in the near future will no doubt depend to some extent upon the performance of this engine. While structural features will prevent the gas engine from catching up with the steam turbine in the matter of capacity, it is, nevertheless, more than holding its own, as evinced not only by the Ford engine, but from the fact that both the United States Steel Corporation's plant at Gary, Ind., and the plant of the Maryland Steel Co., at Sparrows Point, Md., are putting in a number of large gas engines.

❋

## The Fireman's Work

A dollar saved in the boiler room should mean more to the engineer or the man who pays the bills than a saving at any other place in the plant. With a given quantity of coal it means more steam and consequently greater initial energy to begin with. In the engine room, as much as possible of this energy is utilized, but the boiler is the source and any effort that may be made to increase its economical production benefits the plant twofold.

Admitting that this is true, and most of us will, it would seem that the position of the fireman in the power plant is one of the utmost importance. The engine room may contain units of the latest type, operating under a high vacuum and a load factor approaching unity, the steam pipes may be thoroughly covered and every detail arranged for maximum economy, yet the saving that all these refinements might effect would only be a small percentage of what the skillful fireman could do in the boiler room.

Dipping water from one barrel to another with a strainer is not an economical method. The second barrel may be tight and hold all the water it receives, but the loss in the initial supply would be enormous. A dipper is needed, and in the power plant this is an expert fireman. That such men are available in all that the name implies is being realized, but, unfortunately, there are many "strainers." There are firemen who measure their ability by the tons of coal shoveled per day, who know very little about the quantity of air required, and nothing at all about combustion and the possibilities of flue-gas analysis. Even the subject of draft, ordinarily so simple and all important, is apparently given little attention by the man who cannot or will not be a fireman.

There is nothing intricate about a draft gage. It is easily read and if these readings are properly interpreted they will serve as an excellent guide to the best method of firing and the proper intervals between. They will tell the uptodate fireman the condition of his fires from one cleaning to the next. They will tell him how much coal he can expect to burn per square foot of grate surface and, therefore, tell him how much steam the boiler will supply.

A case came under our notice where an economizer was installed. Ordinarily a saving in the vicinity of ten per cent. is credited to this apparatus. In this particular plant, however, the fireman admitted so much air to the furnace that there was very little left for the economizer to do.

In another case the draft in the furnace proved to be insufficient. The plant was loaded down to the limit. More steam was needed and it was impossible to burn any more coal on the grates. A new boiler was recommended but before the purchase a thorough investigation was made. The stack was found to be of the right height and diameter, the boilers were clean and apparently neither the baffling nor the damper interfered with the passing of the gases. Two right-angled turns in the breeching proved to be the cause of the trouble. An obstruction at the time of installation was the reason given, but this had long been removed and the tortuous path of the breeching had never been straightened. With this defect remedied more air was supplied, the combustion was better, and enough steam was generated to meet the demand.

If the fireman had used his draft gage the cause would have been revealed and it is likely that he would have noticed the defect in the breeching. He was shoveling all the coal that the furnaces would burn and naturally he thought that he had reached the capacity of the plant.

Many other cases of a similar nature exist. Thousands of dollars are needlessly wasted in the course of years, and all through neglect of a device so simple as the draft gage If failure to realize its importance is

the excuse offered, it is high time for the fireman to get busy. He must realize that he is an important factor in the plant and that its overall economy depends more upon him than any other man. In short, it is up to him to learn his trade so thoroughly that he will be recognized as an expert on combustion rather than a shoveler of coal.

## Steam Power in Gas Works

It would seem that the phenomenal progress made in methods of operating steam boilers in very recent years would be evidenced in the boiler houses of every industry, but such is not the case. In various kinds of manufacturing plants one still finds the attention of the management concentrated almost solely on the production end of the business, while the power end is left to get along in the same old way, giving the same old service—unforgivably wasteful, but continuous, if "nursed" constantly.

An industry that was (some would say is) slow to take advantage of the improvements in boiler operation is that of illuminating-gas generation and distribution. The product of a gas works is gas, and generators, blowers, purifiers and candlepower are worthy of a gasman's consideration, but steam boilers are objects to be scorned. Such was and is the attitude of many men who have been "brought up" in the illuminating-gas business.

Several years ago if one had suggested to the average gas man that he plot curves and otherwise record the performances of the steam end of his plant, he would have regarded the suggester as one of those demagogues of technics who make life so miserable for many practical men. Yet there are now gas works the steam end of which is conducted according to the most modern methods, where complete record systems prevail and where experiments are being made to determine the advantages and disadvantages of this or that method of accomplishing a given result. In short, there are now many gas works where as much attention is being paid to the steam end as is devoted to the generation of the gas.

Those familiar with gas works know that for years the tar, a byproduct, was pumped into the rivers or waterways at night by the hundreds of gallons so as to get rid of it at the least cost, even though violating the local laws in doing so. It was a long time before it was thought worth while to burn it under the boilers. This is now being done in most plants and the coal consumption for steam purposes in the gas industry has been materially lessened thereby. In some localities there is a good market for this tar and it is hoped that if its use in boilers is discontinued, improved methods of burning the breakage from the gas (lump) coal will be used. This breakage amounts to about seven per cent. by weight of the total lump coal and the latter is usually quite high in cost, therefore, the most economical means of burning the breakage should be found and practiced.

Considerable warm water is needed about a gas works in the winter. The engines used for driving the gas blowers and other purposes might advantageously be run condensing and the warmed circulating water passed out in those systems requiring warm water. These systems would, in a measure, act as cooling towers. It should not be difficult to carry the desired vacuum on the engines or turbines and at the same time maintain the required temperature in the systems requiring warm water.

We know of one plant where this manner of heating is being successfully practiced in keeping a large gas holder supplied with warm water. Conditions here differ somewhat from those existing in a plant where nothing but gas is made. This station furnishes current for power and lighting, and, of course, the turbines are of greater power than the engines used for blowing gas; consequently they furnish more exhaust steam and are able to keep the water in a large gas holder above 32 deg. even in exceedingly cold weather. But, consider the number of gas works there are that are combined with electric-generating plants and under the same management. Practice shows that it requires about 150 boiler horsepower constantly to keep the water in a 5,000,000-cu.ft. gas holder at the required temperature after it has been heated. Think of the coal it is possible to save then by heating the numerous holders throughout the country by warm circulating water from condensers.

After all, the average gas-works engineer has received his mechanical-engineer degree or he has had a goodly amount of boiler practice and he can make the steam end of his plant economical if he will. All that is required is to bring to his mind the fact that there are other important things in engineering beside gas making.

## A Good Example

A few months ago the gas company in Indianapolis voluntarily declared a further reduction in its rates. While this benefited only the large consumers, the point is that it was not necessary to force a reduction by legislation or the control of a public-service commission. There would be more such instances if more of our public utilities gave as much attention to striving to reduce their costs and thereby their charges as they do to lobbying. It is high time that the engineering and not the political talent in a corporation should come in for the chief share of recognition.

Commenting editorially on the gas-price reduction the *Indianapolis News* said: "Indianapolis is fortunate in possessing at least one public-service corporation that regards the business of supplying the public with its necessities as an affair of mutual benefit."

As a consequence this company has no anxiety over laws that may be passed, for laws are not created to affect the good but the criminal. Most public-service corporations remind us of the average boy who would rather spend his ingenuity in getting out of the punishment his disobedience earned than to be good in the first place. When will our utilities corporations grow up?

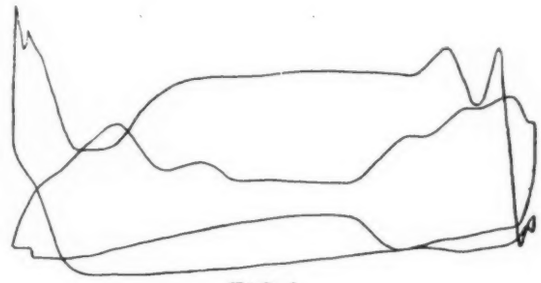
Did you ever try plotting curves showing the coal consumption compared to the evaporation and kilowatt output? Try it and keep the chart in the boiler room. The men will better results or "bust." That's the spirit it creates.

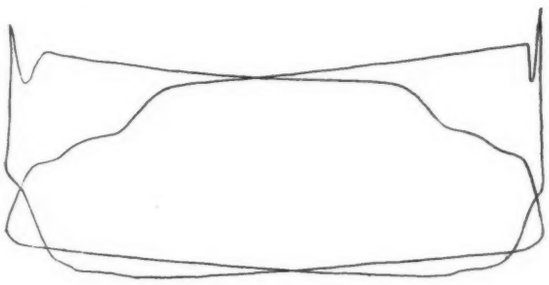
Don't be afraid to let the oiler key-up and put in a unit on the board, set pump valves and such like. Let him take the various meter readings occasionally, too. Polishing brass and filling lubricators does not make real oilers.

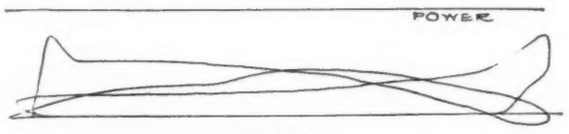
# READERS WITH SOMETHING TO SAY

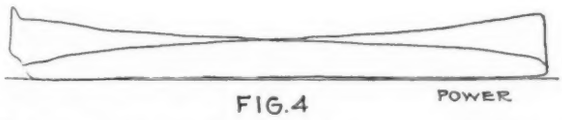
## Compound Traction-Engine Diagrams

The inclosed cards were taken from a 6 and 9 by 10-in. compound traction engine equipped with a Giddings valve and having a single eccentric. The engine is reversible by suitable gear, which slides the eccentric over the shaft in the usual way. The boiler pressure was 80 lb. and a 40-lb. spring was used; the engine ran at 200 r.p.m. The engine was operating satisfactorily apparently, but when the indicator was applied, diagrams, Figs. 1




Diagrams from Compound Traction Engine

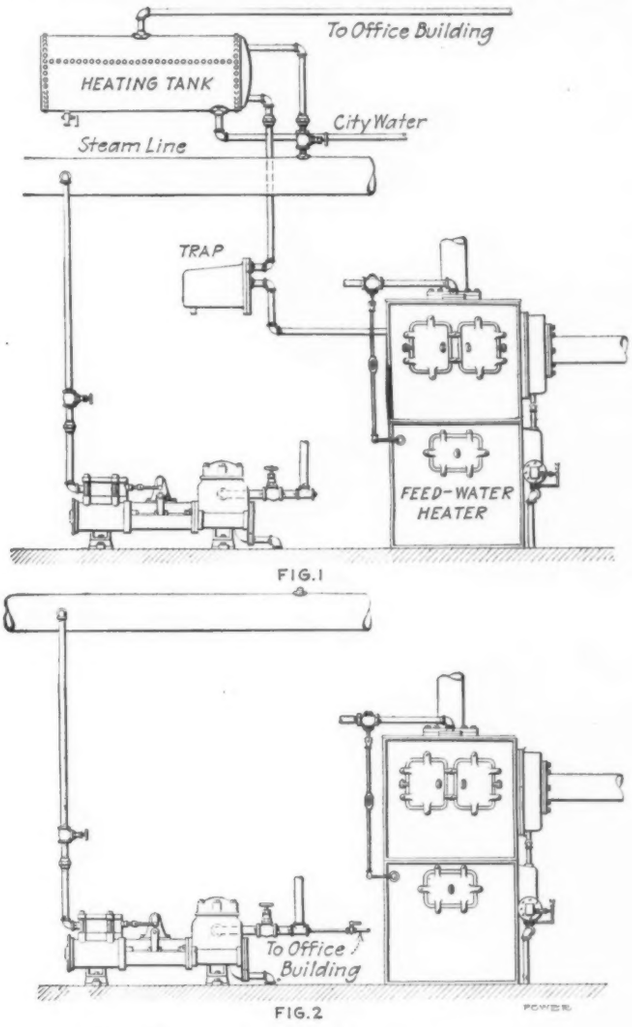
and 3, were obtained. After adjusting the valve rod to the proper length the result was as shown in Figs. 2 and 4. No further change was made, although I believe an increase in the lead would be beneficial.

I should like to hear comments on these diagrams from anyone interested.

Memphis, Tenn. F. P. Read.

## Water-Service Connections Changed

We supply an adjoining office building with light, heat and hot water; the water being used in the lavatories. The original system of furnishing the hot water is shown




Hot-Water Service-Pipe Connections

in Fig. 1. Securing the consent of the manager we made the changes shown in Fig. 2.

When one considers that the office force works only nine hours per day (the plant operates 24), the old way of heating the water was rather expensive. With the present layout we have done away with 300 ft. of ¾-in. pipe, a trap and the heating tank. The pump shown is a boiler-feed pump, so there is boiler pressure on the service-water lines, but in the two years this system has been in operation we have experienced no trouble of any kind.

Roscoe Willey.

Lamoni, Iowa.

[Connections, such as shown in Fig. 2, are hardly to be recommended, especially if the boiler pressure is over

80 lb. Pump governors will sometimes fail to act when the feed valves are closed and with connections like the above the service-water lines would be subjected to too high a pressure.—EDITOR.]

## Cleaning Plugged Feed Pipes

We have two return-tubular boilers, and the feed water contains a high percentage of scale-forming properties; the feed lines plug up in three months and I have to renew all piping from the pump to the extreme end of the delivery pipe. The fittings in the connections stick so that they can hardly be turned with a 3-ft. chain tong.

The dread of the job helped me to plan out the following. I had a drill bit made of a piece of ¼-in. strap iron, similar to an ordinary coal-drill bit. Then a ½-in. pipe fitting was welded to the end, so I could screw on any length of pipe. Then all the ells on the feed lines were displaced by crosses and tees.

Now, when I wish to loosen the scale in the pipe, I take the plugs off the crosses and tees and insert the drill. The drill is about ⅛ in. smaller in diameter than the inside diameter of the pipe.

ROY L. PETERSON.

Knoxville, La.

## Peculiar Experience with Air Pump

Our air pump, connected to a large jet condenser, had been pounding and acting queer for some time. The first indications were light knocks and pounds. Apparently the knocks were in the connecting-rod or cylinder, but keying up on the crank and crosshead brasses helped but little and the remedy lasted only for a short time.

At times the pounding was unusually severe for a day at a time and longer, and then it would suddenly quiet down again. The valves of the air pump were gone over thoroughly, the steam valve examined and the clearance of the steam and air cylinders checked, and all found correct. All brasses were taken up and all lost motion eliminated, but the noise remained.

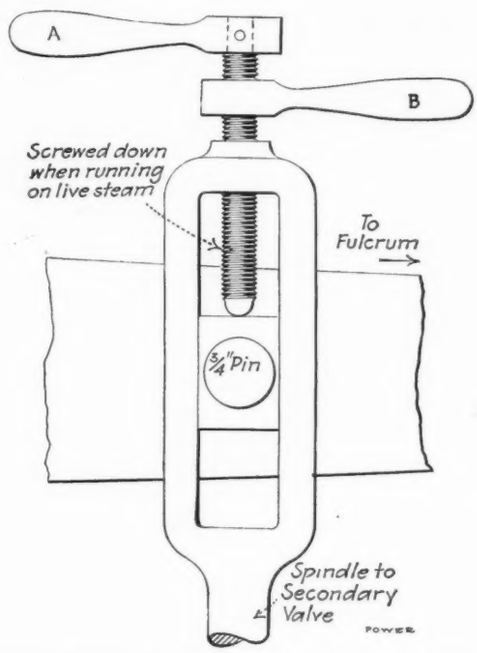
One day the pump started an abnormal racket and was shut down at once. Investigation showed that the piston rod broke close to the piston. A new rod was ordered and put in, the pump examined and started again. The noise was as bad as ever.

Then a series of serious accidents to the pump followed. The bedplate cracked, another piston rod broke and the crosshead split through at the pin bore. Just before the time for the day shift to come on duty the pump began a terrific pounding and was shut down. The night crew claimed it was due to water in one of the cylinders and left it to the day shift to "fight it out." Drains were unusually well provided for and apparently in good working order. Later the check valves in the cylinder drain pipes were found to be all worn out so a pair of new ones were put in. The pump ran smoothly now, but its doing so did not clear the mystery of where the water came from. The drain pipes from the air cylinder were found to end in a trench for the pump-suction pipes in the basement, and some conscientious steam fitter in connecting up the pipe had run it nearly to the bottom of the trench which at times was partly full of water. When the check valves failed, this water was drawn into the pump and caused all the trouble.

THOMAS G. THURSTON.

## Improvement to Secondary Valve of Turbine

When running our low-pressure turbine we have to change over from exhaust steam to live steam about six times in every 24 hours. This is done by screwing down the ⅜-in. set pin or screw shown, thereby lifting the valve to admit live steam, after which we close the exhaust-steam valve. The arrangement sent out by the builders had a small square left on the top of the setscrew and a ⅜-in. jam nut was provided to set the screw when screwed down. This necessitated the use of two wrenches,




ADJUSTING SCREW OF SECONDARY VALVE OF TURBINE

which were not usually in place when needed, as sometimes it is necessary to quickly change over from exhaust to live steam to avoid a shutdown.

In place of the former arrangement I turned up two small handles *A* and *B* and filed out a square hole in *A* to fit the screw and secured it by means of a pin. In place of the nut I tapped out the other handle and now we can operate the valve without losing time looking for wrenches.

J. A. CAMPBELL.

Providence, R. I.

## Air-Driven Pump Freezes

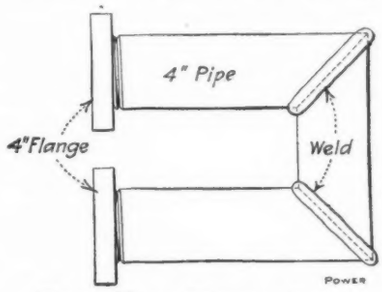
Can anyone tell me how to keep a small Snow pump from freezing under 50 lb. gage pressure without the aid of fire or other heating appliances. The pump stands about 300 yd. from the air compressor, which furnishes air to run the pump, no steam being used.

H. R. LEONARD.

Uniontown, Penn.

## Economizer Repair

We have an economizer containing 600 tubes, made up of sections with goose necks to take up the contraction and expansion. One of these necks failed, and as the economizer could not be spared for any length of time a




HOME-MADE RETURN BEND

goose neck was made out of three pieces of 4-in. pipe and two flanges, as shown in the sketch. The two welds were made with acetylene gas and were built up strong. This repair stood the test and was used until a new goose neck could be secured.

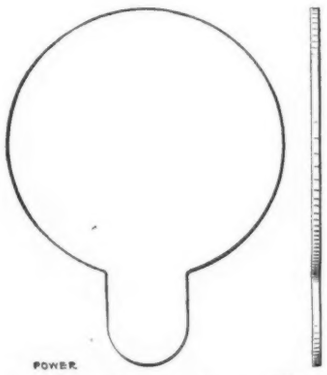
FRANK W. BELLINGER.

St. Paul, Minn.

## Renewing Gaskets in Flanges

When placing a ring gasket in a joint in a vertical pipe the gasket sometimes falls down in the pipe. When such joints will not come apart much, we overcome gasket-insertion troubles as follows:

After removing, say, one-half the bolts, drive in between the joint a steel wedge, until the joint opens about




SHEET-IRON GASKET HOLDER

$\frac{3}{8}$ in. Scrape the old gasket out and see that the flanges are clean. Cut the new gasket to the required size, inside edge of the bolt holes and lay it on a piece of sheet iron of the same diameter or a little less. Cut the sheet iron to the shape shown, lay the gasket on the plate and slide both in. When they are touching the back bolts, hold the gasket with a rule or pocket knife while the plate is withdrawn. It is well to have a number of different-sized plates on hand.

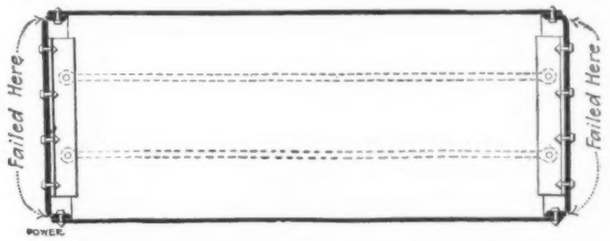
J. JEFFRIES.

Chicago, Ill.

[A plate of this kind may assist in putting a gasket in a large-diameter flange, because a thin and flexible gasket will sometimes strike the internal diameter of the flange at the back end; it should hardly be needed with small flanges, say, 6 in. or less.—EDITOR.]

## Why Did Hot-Water Tank Fail?

The illustration shows the construction of a hot-water tank which gave out after only five years of service. Was failure due to the breathing action we hear so much about in connection with lap-joint boiler construction? This tank was subject to a pressure of from 90 to 100 lb. per




CONSTRUCTION OF TANK THAT FAILED

sq.in. with practically no air cushion to counteract the ramming effect of the pump plunger.

As seen from the sketch the heads were stiffened by angle iron, but with no through rods to hold the latter in position it makes a poor substitute for bumped or braced heads.

The heads were cracked and pitted completely through, nearly all around the circumference at the point shown by the arrows and were about ready to blow out when discarded for a new tank.

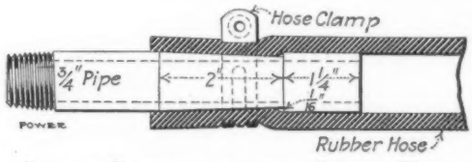
I would like to hear readers' opinion as to the cause of the failure.

R. CEDERBLOM.

Chicago, Ill.

## Steam-Hose Clamp

After having considerable trouble with a steam hose blowing off of the connection, I made the clamp shown. A piece of common $\frac{3}{4}$-in. pipe is turned to a taper and




CLAMP CONNECTION FOR STEAM HOSE

having a shoulder $\frac{1}{16}$ in. deep and $1\frac{1}{4}$ in. from one end of the hose. The hose should be put on this pipe and clamped.

We have a hose with a connection like this which has been in use for the past four months and it withstands a pressure of 115 lb. of steam and has never shown any signs of leaking or tendency to blow off.

H. R. WILLIAMS.

Grand View, Tex.

## Mark for Lubricator Feed-Valve Wheel

It is convenient to have a mark on the feed-adjusting valve wheel of a lubricator. Instead of cutting a notch in the wheel as is common, a hole drilled in the wheel and a brass brad driven in is much better.

HARRY D. EVERETT.

Fort Snelling, Minn.

# QUESTIONS BEFORE THE HOUSE

## Experiments on Efficient Boiler Operation

In the June 3 issue, there appeared an article entitled "Experiments on Efficient Boiler Operation," by B. W. Rogowski and, as I am interested in the subject of the combustion of all kinds of fuel, I have gone over the article very carefully and so far as I can see, the writer has failed to do more than to show that he apparently improved his efficiency by cleaning his boilers. He does not discuss the vital points, nor show what economy he actually obtained.

He states that the boiler fuel depends largely upon "the choice of coal adaptable to the plant conditions, and which would generate the greatest amount of heat at the lowest cost of handling and consumption." He does not state the location of the plant in question, the price of the various sizes of anthracite, such as pea, buckwheat, rice and barley; nor the make of boilers and type of baffling in question. It is impossible, therefore, to discuss with any amount of intelligence the correctness of the writer's statements, but it appears that the matter has not been approached from the proper viewpoint.

If other coals were available, such as mentioned, that is, the small sizes of anthracite, it certainly would pay to change the grates to accommodate the fuel and not have the fuel accommodate the grates. With the excellent stack draft very fine showings should be made with the smaller sizes of anthracite fuel, in conjunction with mechanical draft-blower apparatus.

Flue-gas analysis, when it comes right down to boiler-plant efficiency, means very little, except the $CO_2$ reading, which, I believe, it is well to obtain, and if possible to record with a gasometer; but it is not flue-gas analysis that is required but rather how low the cost to evaporate 1000 lb. of water from and at 212 deg. F. may be made. If the efficiency of the plant is to be known, all tests are of no avail unless this figure is obtained, using various fuels, which the writer evidently has not done, or if he has, has said nothing about it. If the writer is determining efficiency of his plant purely by the analysis of the flue gases he is apt to be very much in error, since his boilers may be in a very dirty condition inside, which will have no effect on the flue-gas analysis and yet will greatly affect the evaporation.

Experiments with the thickness of the fuel bed were made and it seems, according to his results, that a 4½-in. bed was found most efficient with mechanical draft and a very high stack with good draft and grates of 25 per cent. air space. I do not agree with him in view of the fact that his rate of combustion is exceptionally low; 17 lb. per sq.ft. of grate surface. Cleaning for a 4½-in. fire means a very great loss and is unnecessary, as with both mechanical and natural draft a 10-in. fire can be easily handled and maximum efficiency still maintained.

The writer states further on, that the combination of this highly preheated air and carbon monoxide at the bridge-wall secured complete combustion. Evidently this boiler has horizontal baffles, and I should be glad to learn as to the correctness of this assumption.

It is stated that alternate firing gives best results, that is, one-half of the grate at a time, and the general conclusion is stated as a fact and applied to anthracite generally, which is erroneous. If this were done with No. 3 buckwheat or barley more air would pass through the well burned half of the grate, rather than through the green coal, and even with No. 1 buckwheat and natural draft, this will hold true. It is also stated that the fire must not be disturbed except when cleaning. It is impossible to burn rice or barley and even No. 1 buckwheat, without leveling the fire occasionally with a leveling rod.

Of all anthracite coals, such as pea, buckwheat, rice and barley, buckwheat is most expensive, as it contains less heat units per dollar. Of course, it must be compared with the other sizes from the same vein. I might state here that with No. 3 buckwheat, or barley, of quality such as was named (12,500 B.t.u.) a fire can be obtained which is incandescent and which will evaporate more steam per pound of coal than No. 1 buckwheat of the same vein.

It would have been a good thing had Mr. Rogowski given more information regarding his tests, stating how they were made, analysis of the coal, how the water was weighed, the conditions of the boilers, percentage of boiler rating developed and pounds of water evaporated per pound of coal.

V. H. CARPLES.

New York City.

❖

## Measuring Water during Boiler Tests

In looking over Mr. McHollan's feed-water piping, as illustrated in the letter on the above subject in the June 10 issue, for measuring water in boiler tests, I notice that he proposes to draw or lift hot water from two flat storage tanks, located below the water chambers of the boiler-feed pumps.

Assuming that the feed water is as it should be, very near the boiling point, I cannot see how the arrangement could work successfully if installed, as shown by Mr. McHollan, for the reason that it is impossible to lift hot water any considerable distance by suction, as the vapor pressure or tendency to turn it into steam closely approximates and counterbalances the atmospheric pressure. If it is attempted to lift hot water by suction the body of the water will not rise, but instead, steam or vapor arises from the surface and flows to the pump. This vapor and steam in the water chambers will, of course, cause the pump to race and knock without delivering any appreciable amount of water.

The cure for this condition is to have the water flow to the pumps by gravity with sufficient head to lift the suction valves in the pump, to overcome the friction in the piping and to flow with sufficient velocity to follow

the pump plunger in a solid body. Therefore, in Mr. McHollan's layout, the pumps should be lowered sufficiently to allow the hot water to flow from the collecting tanks by gravity.

The points above mentioned bring to mind one of my experiences with an open-heater installation, as shown in Fig. 1. The boiler-feed pump was about 30 ft. from the heater and the situation was such that it was impossible to get more than 2-ft. drop between the hot-water

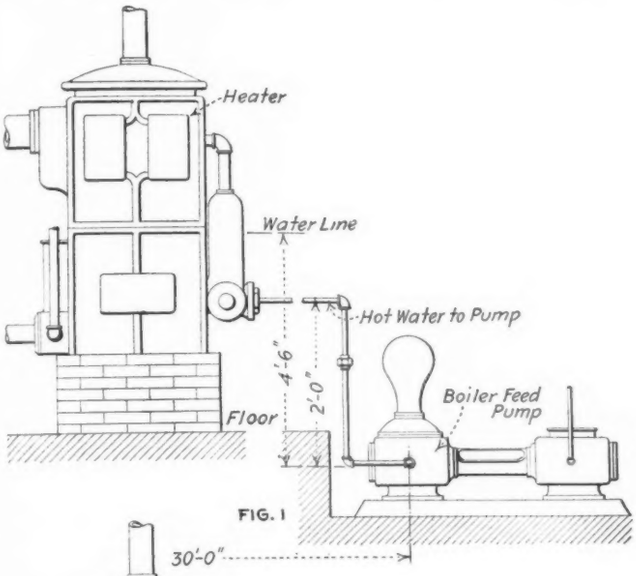



FIG. 1

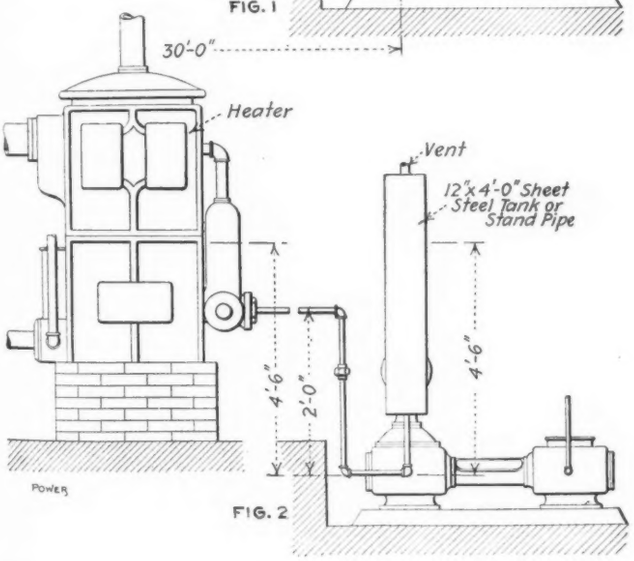



FIG. 2

HEATER CONNECTIONS TO PREVENT POUNDING OF PUMP

outlet of the heater and the water chambers of the pump. While we could pump the water we were annoyed quite often by the racing and knocking of the pump when the slugs of vapor collected. Realizing that it was necessary to keep a constant supply of water to follow the pump piston, I installed a standpipe arrangement above the feed pump, as shown in Fig. 2. This tank maintained a head of water at the pump equal to the height of the water line in the heater. After putting this arrangement into operation, the trouble from pumping the hot water was eliminated.

WILLIAM TAYLOR.

Philadelphia, Penn.

[Troubles of this kind are common and the standpipe should eliminate them.—EDITOR.]

## Japanese Electrical Manufacturers

Regarding the Japanese as electrical manufacturers, commented on in POWER for May 13, 1913, an agent of one of our leading electrical manufacturers recently told me his firm had been requested to bid on an order from Japan for one or two only of about every kind of electrical apparatus they manufactured. He could only conclude, from the peculiar makeup of the order, that the instruments were to serve as models to be imitated.

DONALD M. LIDDELL.

Elizabeth, N. J.

## Large High-Vacuum Condenser Test

I have noted with interest Mr. De Laval's communication in your issue of May 27, in which he refers to the test of the Illinois Steel Co. condenser, published in the Feb. 25 issue.

Mr. De Laval assumes that the vacuum readings were taken on the air-pump suction, and he is apparently under the impression that in any condenser of this size there must be a loss of approximately 1 in. in vacuum between the turbine buckets and the dry-air pump-suction opening.

The test in question, which was conducted by the engineering department of the Illinois Steel Co., was one of the most complete condenser tests that has been made. These engineers were only interested in the vacuum at the turbine, and, hence, the vacuum readings, instead of being taken at the air-pump suction, as Mr. De Laval assumes, were actually taken at four points at the top of the shell in the space directly beneath the turbine buckets.

It may also interest Mr. De Laval to know that the total loss in this condenser averaged less than 0.2 of an inch.

There is a further reference made to the test of the dry-vacuum pump, where Mr. De Laval makes certain deductions as to efficiency, by taking readings from indicator cards and making no allowance for barometer corrections. The dry-vacuum pump test was made at the same time as the condenser test, and is based on operating conditions where the corrected vacuum varied from 28.3 to 28.9 in.

Mr. De Laval asked if the Wheeler Condenser & Engineering Co. is willing to guarantee the efficiencies obtained by the Illinois Steel Co.'s engineers, and I beg to state that we would not only be pleased to duplicate this performance, but to improve on the results in many respects.

J. J. BROWN.

Carteret, N. J.

## Name for Steam Stuff

The various names for steam suggested by C. S. Palmer in the May 20 issue are noted. If we are really hunting for a new name for our faithful friend, why not "super-steam" for superheated steam; "steam" for dry steam; "wet steam" for wet steam. Otherwise, if a spade is not a spade, what is it?

E. R. PEARCE.

Rochdale, England.

# INQUIRIES OF GENERAL INTEREST

**Engine Speeds**—About what are the respective speeds of Corliss and high-speed engines in common use?

A. C. M.

Corliss engines are made to run at 80 to 150 r.p.m. High-speed engines are made to run at speeds of 150 to 700 or more r.p.m.

---

**Boiler Evaporation**—What is the normal average of evaporation of water in a steam boiler, in pounds of water per pound of coal?

H. R. B.

In average good boiler practice 8 lb. of water is evaporated from and at 212 deg. F. (or equivalent) per pound of coal.

---

**Electric Lamp Load**—What would be the load on a dynamo lighting 50 incandescent lamps, all in one building but on four floors and connected by about 500 ft. of wiring? Our dynamo is rated at 5 kw., 125 volts, 40 amperes; is it large enough?

W. Y. J.

Fifty 16-cp. carbon-filament electric lights would require about 25 amperes with current at 110 volts, or 2.75 kw., and the dynamo which you describe should be ample for supplying the lamps. Tungsten lamps for a given candlepower consume much less current and nearly twice as many can be lighted with the same current consumption.

---

**Varying Receiver Pressure**—What can cause the receiver pressure in a cross-compound, nonreleasing, shaft-governed engine to rise and fall? The governor is understood to control the cutoff of both the high- and low-pressure cylinders. There is no change in the load or in the initial or back pressure?

M. B. H.

Diagrams taken from the engine would undoubtedly show that there is a hunting action of the governor, producing a constantly varying per cent. of cutoff. It is doubtful if the load can be said to be absolutely constant because there are always slight changes due to friction variations, etc.

---

**"No-Voltage Release"**—What is meant by a "no-voltage release," of what does it consist and what is its purpose?

F. E. A.

The correct term is "low-voltage release," although the other is frequently used. It is a relay wound so as to trip the circuit-breaker, or switch, when the voltage falls below a certain predetermined value, usually 50 per cent. of the normal voltage. These devices are used in connection with motors to insure proper starting. If the voltage should drop suddenly, while the motor is running, to such a low value that the motor stops, and then should come on again the motor would not be damaged by a rush of current, because the low-voltage release woud have opened the circuit.

---

**Detecting Leaky Slide Valve**—How can a leaky slide valve and a leaky piston be detected?

J. C. M.

A leaky slide valve can be detected from the character of the exhaust. If the valve leaks, steam will be discharged after the valve has cut off, i.e., there will be a continuous stream instead of an intermittent discharge. Another way is to place the engine so the valve will be in the middle of its travel, then block the engine from turning. If the valve is tight no steam will escape from the exhaust pipe or cylinder pet-cocks when steam is admitted by the throttle valve. A leaky piston is best detected by removing the cylinder head and, after blocking the wheel or crosshead, with the piston at about one-half stroke, open the throttle valve and observe whether steam blows past the piston.

---

**Finding Pump Size**—What size pump, and what horsepower are needed to feed two 71-hp. boilers through a 1-in. pipe, 11 ft. long containing six ells, and through a closed heater 6½ ft. long containing 10 ft. of 1-in. pipe with 18 return-bend connections, and then back through a return pipe (1-in.) also 112 ft. long and containing six ells and four valves? The water must be lifted 15 ft. and delivered against 100 lb. boiler pressure.

A. M.

To feed two 71-hp. boilers would require

$$2 \times 71 \times 30 = 4260 \text{ lb.}$$

of water per hour, or

$$\frac{4260}{8.33} = 511.2 \text{ gal. per hr.}$$

or

$$\frac{511.2}{60} = 8.5 \text{ gal. per min.}$$

Reckoning the friction of each 1-in. valve or fitting as equal to that of 20 ft. of 1-in. pipe, then the total equivalent length of pipe would be

| | |
|---|---|
| $112 + (6 \times 20) =$ | 232 |
| $120 + (18 \times 20) =$ | 480 |
| $112 + (6 \times 20) + (4 \times 20) =$ | 312 |
| | 1024 ft. |

Referring to Plate I of diagrams of loss of head in pipes given in the Nov. 10, 1908, issue of "Power," page 778, it may be seen that water flowing in 1-in. iron pipe at the rate of 8.5 gal. per min. sustains a loss in head of 9 ft. per 100-ft. length of pipe, hence for 1024 ft., the loss of head to overcome friction would be

$$\frac{1024}{100} \times 9 = 92.16 \text{ ft.}$$

head or

$$92.16 \times 0.433 = 39.9 \text{ lb.}$$

or practically 40 lb. per sq.in., which would be the loss of pressure due to friction.

For pumping the quantity of water required per minute a 3x2x3-in. duplex steam pump running at about 60 r.p.m. would answer, but a 4½x2¾x4-in. duplex pump running at about 40 r.p.m., or a 5x3¼x8-in. single steam pump running at about 38 r.p.m. would give better satisfaction.

The total pressure to be overcome would be

$$40 + 100 + (15 \times 0.433) = 146\tfrac{1}{2} \text{ lb.,}$$

and pumping 8½ gal. per min., the net water horsepower would be

$$\frac{8\tfrac{1}{2} \text{ gal.} \times 231 \text{ cu.in. per gal.} \times 146\tfrac{1}{2}}{12 \times 33{,}000} = 0.726 \text{ hp.}$$

and if a steam pump is used it would require about

$$0.726 \times \frac{150}{30} = 3.63 \text{ b.hp.}$$

of steam.

Using a 1¼-in. suction pipe up to the heater, the power required would be about 10 per cent. less than by the restricted use of 1-in. pipe as above.

---

**Pumping Power**—What horsepower should be necessary to operate a pump delivering 526 gal. per min. against a pressure of 210 lb.? The water is delivered to the pump so that no lift is necessary. With current at 1¾c. per kw.-hr., what would it cost per month of thirty 8-hr. days to drive the pump by a motor?

J. C. G.

Pumping 526 gal. per min. against a pressure of 210 lb. per sq.in. requires

$$\frac{231 \times 526 \times 210}{12 \times 33{,}000} = 64.43 \text{ net horsepower,}$$

and allowing 60 per cent. efficiency of the pump, this would require

$$\frac{64.43}{60} = 107.38 \text{ net or brake-horsepower}$$

to be applied to the pump. Allowing 85 per cent. efficiency of an engine and transmission machinery would require an engine to develop

$$\frac{107.38}{0.85} = 126.32 \text{ i.hp.}$$

With electric current charged for at 1¾c. per kw.-hr., allowing 91 per cent. efficiency of the electric motor and 60 per cent. efficiency of the pump, the charge for current, running eight hours per day and 30 days per month would be:

$$\frac{(231 \times 526 \times 210)}{12 \times 737.3 \times 60)} \times \frac{(\$0.0175 \times 8 \times 30)}{(0.91 \times 0.60)} = \$369.72$$

# ENGINEERS' STUDY COURSE

## Heat Lost in Flue Gases

### Heat Lost up Chimney

When a pound of fuel is burned under a boiler its available heat is distributed in a number of ways. The largest part is transferred to the water within the boiler and converts some of it into steam. But, from 20 to 60 per cent. is lost in various ways. The greatest loss is due to the heat carried up the chimney by the flue gases, and, as this loss depends to a large extent upon the skill and care employed in operation, it is one in which every engineer should be greatly interested and about which he should be thoroughly posted.

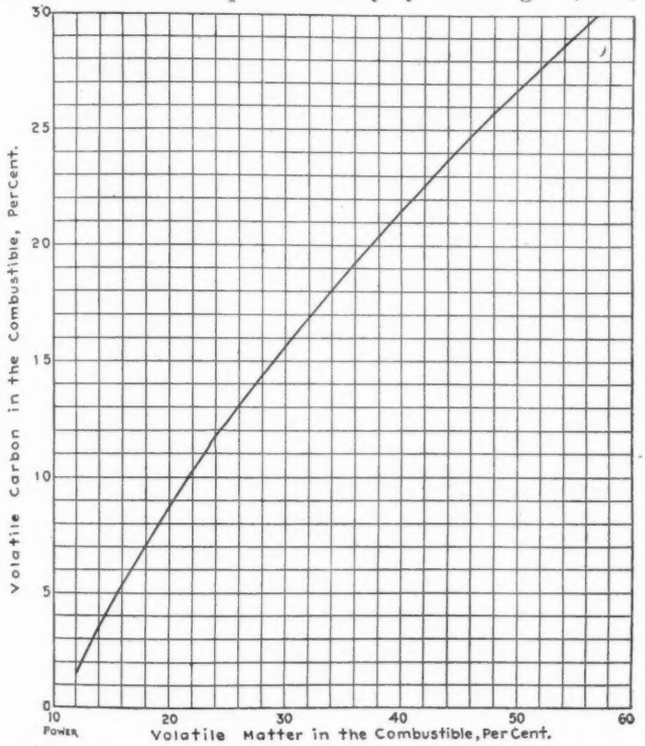



Fig. 1. Chart for Determining the Carbon in the Volatile Matter

If after a pound of flue gas has come in contact with the heating surface of the boiler and has given up some of its heat to the water within, it passes out to the chimney at, say, 500 deg. F., how much heat is lost or carried up the chimney?

All the heat that the gas contains, over and above what the air and coal from which it was formed contained, was derived from the combustion of the coal. Then to all intents and purposes the heat lost with every pound of flue gas, expressed in B.t.u., must be the product of the number of degrees difference in temperature between the air entering the furnace and the flue gas going out of the boiler, multiplied by the heat required to raise the temperature of a pound of flue gas 1 deg.

### Specific Heat

This brings us to a consideration of "specific heat," a term often employed in steam engineering. By definition, the amount of heat required to raise the temperature of a pound of water 1 deg. is one B.t.u. A pound of air requires about one-fourth as much heat as a pound of water for a rise of 1 deg., and a pound of iron requires only about one-eighth as much as water. The quantity of heat required to raise the temperature of a given amount of substance a given number of degrees depends upon the nature of the substance and is different in almost every case. Hence, in problems involving quantity of heat and quantity of materials, it is often important to know the amount of heat required to cause a rise of 1 deg. in temperature per pound of material under consideration. This quantity is called the specific heat of the substance. Thus, the specific heat of iron is said to be 0.13, because a pound of iron requires 0.13 B.t.u. to raise its temperature 1 deg.

The specific heat of flue gas is not exactly known, nor is it uniform for all temperatures. That is, at low temperatures it is somewhat less that at high. However, the most commonly accepted value is 0.24, and, hence this is the one we will use.

### Estimating Heat Lost in Flue Gases

The heat lost or carried up the chimney by the flue gases per pound of fuel burned can be estimated by multiplying the weight of the gases generated per pound of fuel by the specific heat of the gases and the difference in temperature between the gases leaving the boiler and the air entering the furnace. The answer expresses the loss in B.t.u. This calculation can be written as a formula, thus:

$$L = 0.24\ W\ (T - t),$$

where

$L$ = B.t.u. lost up chimney per pound of fuel burned;

0.24 = Specific heat of the flue gases (or the amount of heat required to raise 1 lb. of the gases 1 deg.);

$W$ = Weight of flue gases formed per pound of fuel;

$T$ = Temperature of gases leaving boiler, degrees F.;

$t$ = Temperature of air entering furnace, degrees F.

### Weight of Gases per Pound of Fuel

To make the foregoing calculation it is necessary to know the weight of flue gases formed per pound of fuel burned. This is found by the following formula, which looks worse than it really is:

$$W = 3.032\ C\left(\frac{N}{CO_2 + CO}\right) + (1 - A)$$

where

$W$ = Weight of flue gases formed per pound of fuel burned;

3.032 = A constant;

$C$ = Decimal part by weight of carbon (total

carbon) in the fuel as fired;

$N$ = Percentage by volume of nitrogen in the flue gases;

$CO_2$ = Percentage by volume of carbon dioxide in the flue gases;

$CO$ = Percentage by volume of carbon monoxide in the flue gases;

$A$ = Decimal part by weight of ash in the fuel as fired.

The proximate coal analysis does not show the decimal part, proportion or percentage, of total carbon in the fuel; it only shows the percentage of fixed carbon. Consequently, in order to use the foregoing formula, we will have to estimate or guess at the amount of carbon contained in the volatile matter, add this to the amount of fixed carbon and consider the sum as being the amount of total carbon in the fuel. The accompanying chart, Fig. 1, developed by Professor Marks and originally published in POWER for Jan. 14, will give results close enough for our purpose.

### Estimating Total Carbon in Coal

To calculate the carbon in the volatile, add together the percentage of fixed carbon and volatile matter as shown by the proximate analysis and divide this sum into the percentage of volatile matter. The quotient multiplied by 100 gives the percentage of volatile matter in the combustible. Having found this, locate a corresponding point on the scale at the bottom of the chart and trace an imaginary line straight up to the curve and then horizontally to the scale at the left margin which gives the percentage of volatile carbon in the combustible matter. Multiply the percentage thus found by the percentage of combustible in the coal and divide by 100 to obtain the percentage of volatile carbon in the coal. Add this percentage to the percentage of fixed carbon in the coal as shown by the proximate analysis to obtain the total carbon in the coal.

To illustrate with a numerical example, assume that we wish to estimate the percentage of total carbon in a coal with this analysis: Moisture, 6.2 per cent.; volatile matter, 16.8 per cent.; fixed carbon, 70.7 per cent.; ash, 6.3 per cent. The sum of the percentage of fixed carbon and volatile matter is

$$70.7 + 16.8 = 87.5,$$

and this, divided into the percentage of volatile matter and multiplied by 100, gives

$$\frac{16.8}{87.5} \times 100 = 19.2 \textit{ per cent.}$$

volatile matter in the combustible.

Locating the 19.2 point on the scale at the foot of the chart and tracing an imaginary line straight up to the curve and over to the margin we get 8.2 as the percentage of volatile carbon in the combustible. And this multiplied by 87.5, the percentage of combustible matter in the coal, and divided by 100, gives

$$8.2 \times 87.5 \div 100 = 7.2,$$

the percentage of volatile carbon in the coal, which, added to the percentage of fixed carbon in the coal, gives

$$70.7 + 7.2 = 77.9,$$

the percentage of total carbon in the coal.

The next lesson will tell how the nitrogen in the flue gases is estimated and how to measure flue-gas temperature. There will also be some practice problems.

## OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Office-building managers are showing much more interest in power-plant efficiency than formerly. It isn't surprising that this is so; the surprise was that they were so long discovering their sore need for better equipment, better engineers, better returns.

⁂

Even the most skeptical must admit that the public service commissions are doing good work when they compel admission from public-utility heads that the commissions are commendable. Usually, a corporation cries persecution unless it can conduct its business just as it sees fit.

⁂

Man says he has a safety razor operated by electricity, and it works beautifully. Now he wants a new motor, as the present one, about the size of an apple (perhaps a pippin), is too bunglesome. One about the size of a B. & S. No. 00 hen's egg, he cal'lates. The razor saws, no scraping whatever. Great! Now for that device with which you can cut your own hair—if you have any; some folks haven't.

⁂

'Bout time old Foodforthought was pensioned; he's sure being worked overtime in the papers. Some of these writer chaps must be eating around in "food-for-thought" places and suffer from literary gout or a superfluity of adipose tissue.

⁂

It's said that New York City intends utilizing the exhaust steam from one of its power plants to help make twenty-five tons of ice daily and sell it at cost price. More municipal misuse of the down-trodden central station. And the more ice the city makes, the hotter will be the central-station people.

⁂

"Don't be content with doing only your duty; do more than your duty."—Andrew Carnegie.

We like this as an aphorism; it has a wide latitude and a broad meaning. But the big hitch in the "doing" business is that its marts are crowded something fierce with ginks who are either doing nothing, or everybody, or just doing. The business is too highly specialized, there's too many competitors, too many enthusiasts—and too many professional reformers.

⁂

One of the most successful kale-gatherers we ever assisted in getting rich had this slogan. "Don't hold a man down; hold him up!" And he practiced as well as preached this doctrine from the rising of the sun to its going down thereof. Hold 'em up? It was Use no Hooks! and This Side Up with Care! but how he could hold, and keep hold.

⁂

He had more than a "howdy-do" acquaintance with Andy, and this is probably where he got the idee of "doing" more than his duty—many more. Mr. Carnegie's one desire is to die poor, and he has duty enough without trying to overdo himself at the rate he is going. If he lives 'till he's poor, the doing business will by that time have slumped considerably, and his impetuous remarks anent the more than duty stunt will have doubtless been forgotten.

⁂

When Wall Street "cuts a melon," it divides up a big hunk of money made on a smart deal; when the N. Y., N. H. & H. cut its Mellen the other day it took a big hunk of subsidiary property from out of his control. My word, old chap, a rawther Mellencholy proceeding, eh what?

⁂

The New Haven system has been further disordered by the Interstate Commerce Commissioner's scathing arraignment of its mismanagement. The commission recommends that the road divest itself of its trolleys. This is a dignified way of saying: "You're off your trolley."

⁂

Proper appreciation is lacking, says "Engineering News," for the hard-working air-brake inspector, to whom is due the safety of the traveling public. Here's credit for one faithful soul in obscurity. Somebody please say a kind word for the power-plant engineer?

# The Care and Repair of Rubber Belts

By Robert Moore

*SYNOPSIS—A well illustrated article giving instructions for splicing and stitching rubber and canvas belts. The author does not recommend the use of rubber belts on small pulleys. Dressing for rubber belts is also considered.*

From time to time one sees articles on the splicing and general repair of leather belting, but rubber and canvas belts seem to have been neglected.

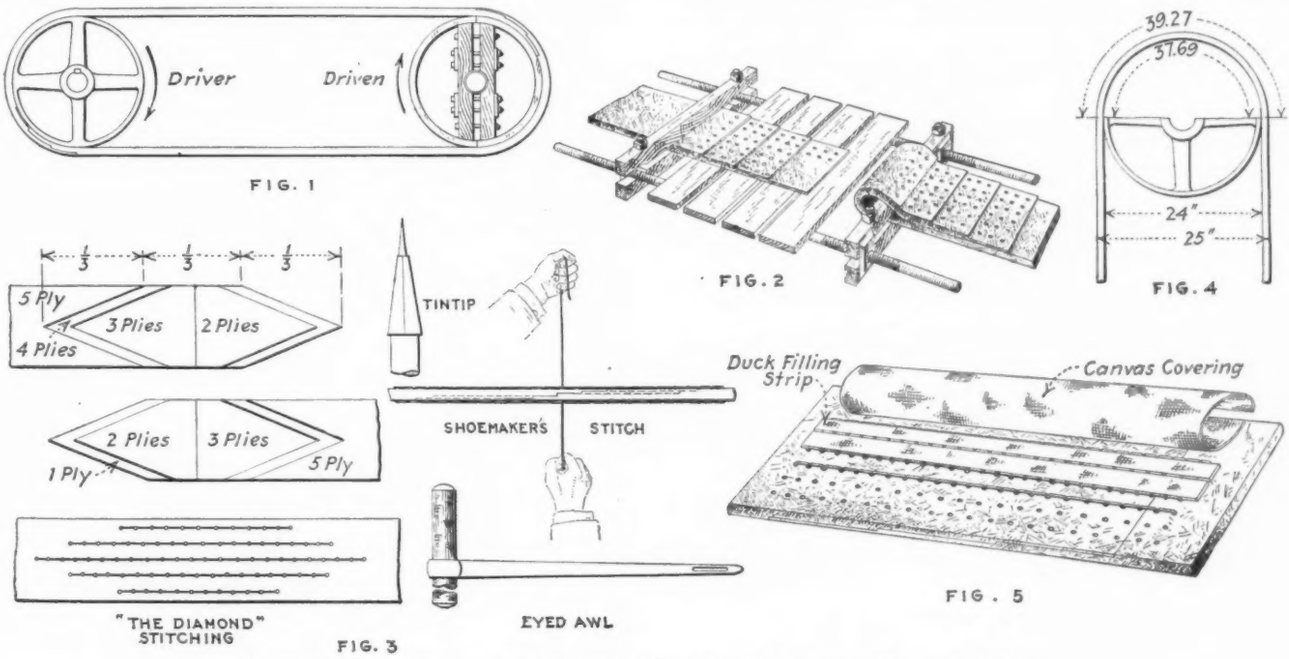
Nevertheless, they need as much attention as their cousins of leather, particularly in the splicing. Some time ago the writer installed a 36-in. belt that was 50 ft. between centers. As belts of this sort are prone to stretch when new, care should be taken in stretching the belt over the pulleys.

First allow ⅛ in. to each lineal foot of belt for stretch, place the belt in position, put on the clamps and draw them tight. Do not be afraid of breaking the belt as five-ply 10-in. belt will stand a strain of 10,000 lb., larger ones in proportion; the pulley will collapse first. Take all the tension the bearings will stand, then turn the shaft slowly back and forth until the clamps touch the pulleys; taking up the slack as it is recovered from the upper half. Neglect to do this will stretch only one-half of the belt, and is apt to cause it to run out of line.

After thoroughly stretching the belt, proceed with the lap, which for a belt of this kind should be 45 in. long. Bear in mind that the lap should always point in the direction of travel over the pulley as in Fig. 1. By so doing any slip of the pulley will have a tendency to smooth down the lap.

Place the board on the clamp rods to rest the splice on; then draw a line squarely across the belt 47 in. from the end. Lay the section off in 2-in. squares, starting one inch from the outer edge as in Fig. 2. Now punch ¼-in. holes where the lines cross. As there are six piles there will be three cuts or scarfs, as shown in Fig. 2. Cut a line just the depth of two plies at the 45-in. line and peel off these two thicknesses; do the same at the 15- and 30-in. lines.

Scarf the other end, place the halves together and punch holes in the lower half, inserting the punch in the holes in the upper half. By so doing, the holes will be directly opposite each other. Cleanse the surfaces with naphtha and apply a liberal coating of the best rubber cement. Allow this to dry until it will not stick to the fingers, then place the laps together, starting at the edge and rolling the upper one out as it is being cemented so that air may not be entrapped between the surfaces. Then sew the outer edges, using the shoemaker's stitch, shown in Fig. 3. Alternately roll and pound the joint until it is perfectly flat, then sew each row of holes as was done with the outer ones.




Stitchings, Splices and Tools Used In Repairing Rubber Belts

Cut filling strips the width of the space between lacings (most belt companies sell this duck all prepared), and give them several coats of rubber cement on each side. Clean the face of the belt between the laces with naphtha and give it a liberal coating of cement. When each surface is dry, that is, when the finger placed lightly to the surface will not adhere, place the strips between the lacing and roll them down. Now take a piece of duck, the width of the splice, but 4 in. longer, and cement this to the face of the belt, covering the joint. By so doing the lacings are protected and except for the occasional renewal of the outer covering the joint is as durable as the belt itself.

In sewing belts of this kind, tip the laces like a shoe string by bending a V-shaped piece of tin around the ends; another way is to use an eyed awl to pull the lace through the belt.

Belts smaller than 10 in. are butted and have a butt strap on the outer surface, this is known as the "back splice." Belts on grindstones, saws, rattlers, etc., where shippers are used will wear on the corners where they are butted, and the outer lace hole will soon tear away, if this form of joint is not used. Shippers for belts of this kind should always be of the roller type. In joining canvas belts always stagger the holes and do not have them less than 1¼ in. apart as the fabric is apt to crack across in cold weather.

Another form of joint, known as the "diamond splice," is used on generators with small pulleys as there is less shock when the lap passes over the pulley, eliminating all flicker of the lamps.

The diamond splice is made in much the same manner as the lap splice except that the scarfs are divided into three equal parts and cut as shown in Fig. 3, it is not so strong a joint as the lap splice, but it is more flexible, therefore, better adapted to small pulleys.

Many engineers condemn rubber belts as too cheap or they consider them as a poor substitute for those of leather. This is a mistaken idea. I personally know of rubber belts that have been in continuous operation for years under most exacting conditions, such as dust-laden grinding rooms, dye house where the belts were drenched with moisture and outdoor drives subject to all weather conditions.

I would not advise using rubber belts on small pulleys as the outer side of the belt must stretch and the side next the pulley compress. This creates a forward and backward motion between the plies of the belt and is apt to separate these plies.

On a given arc the stretch and compression are the same for one thickness of belt, so that increasing the diameter of the pulley lengthens the life of a belt as the stretch and compression are less per foot. As the thickness of the belt increases so should the diameter of the pulley. For instance, the arc of a belt ¼ in. thick, on a 2-ft. pulley would measure 37.69 in. next to the face of the pulley, while the outer edge would measure 38.48 in., a total distortion of 0.79 in. If the belt were ½ in. thick the outer edge would measure 39.27 in., giving a total distortion of 1.58, just twice as much; see Fig. 4.

So when more power is wanted and it is not advisable to increase the size of the pulley better results are obtained by widening the belt and pulley face than to increase the thickness of the belt.

To increase the diameter of the pulley to 48 in. would give a total distortion of 1.58 in. when using a ½-in. belt, but as the arc would measure 75.4 in., the distortion for each lineal foot would be halved.

Animal fats and grease should never be used on rubber belts. Boiled linseed oil is good; also equal parts of black lead, red lead, French yellow, litharge and enough Japan dryer to make it dry quickly. This will give a smooth polished surface.

# Available $CO_2$ Percentages

By H. O'Neill

*SYNOPSIS—Influence of hydrogen and air supply to fuel upon the possible percentages of $CO_2$ resulting from the combustion of fuel composed of carbon and hydrogen.*

The author of "Available $CO_2$ Percentages," in the issue of Apr. 15, correctly states that the percentage of $CO_2$ in a flue gas does not in itself determine furnace efficiency, for the loss to stack of even a small amount of CO means, relatively, a large loss in available heat. Nor does highest $CO_2$ percentage necessarily mean highest efficiency.

However, his method of measuring the possible $CO_2$ percentage by the percentage of fixed carbon in the fuel is fallacious. If it were correct, $CO_2$ could not possibly be produced from the combustion of a hydrocarbon such as oil, which has no fixed carbon. It is certain that the combustion of such fuel does produce $CO_2$.

$CO_2$ percentage is determined by the air supplied per pound of combustible, and by the chemical composition of the fuel. Combustion of pure carbon in air produces by volume: Nitrogen, 79.1 per cent.; $CO_2 + O + CO$, 20.9 per cent. Here, the available $CO_2$ is 20.9 per cent., and the percentage of $CO_2$ obtained, depends upon the amount of air supplied in excess to that required for complete combustion, that is, $CO_2$ will approach 20.9 per cent. as a maximum by proper furnace design and operation.

What really determines the available $CO_2$ percentages is the available total of $CO_2 + O + CO$, or if the combustion is complete, the available total of $CO_2 + O$. This can be calculated only after an ultimate analysis of the fuel, showing the percentage of nitrogen, oxygen, sulphur, hydrogen and carbon.

Nitrogen fixed in the coal will appear in the analyzer

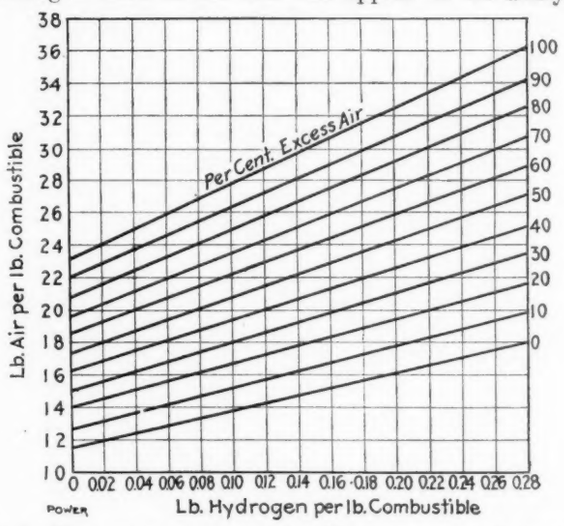



Fig. 1. Relation between Air Required for Complete Combustion and Proportion of Hydrogen in Combustible

in addition to the nitrogen of the air supplied to the fuel. Therefore, the percentage of the available total will tend to be under 20.9 per cent. Oxygen so fixed may combine directly with the fuel without being accompanied

with nitrogen, as in the case of the oxygen in the air supplied. Therefore, when the coal contains oxygen, the nitrogen residue will be decreased relatively, and the available total may run over 20.9 per cent., as is the case with the combustion of certain high-oxygen coals.

The combustion of sulphur in small percentages has an inconsiderable effect on the available total.

With practically all Eastern steaming coals, the hydrogen in combustion has the most important effect on the available total. It may be assumed within reason that

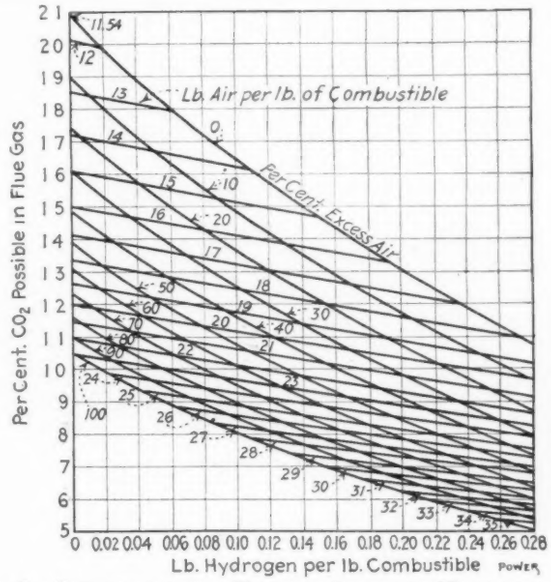



FIG. 2. INFLUENCE OF EXCESS AIR AND HYDROGEN IN COMBUSTIBLE ON $CO_2$ PERCENTAGE

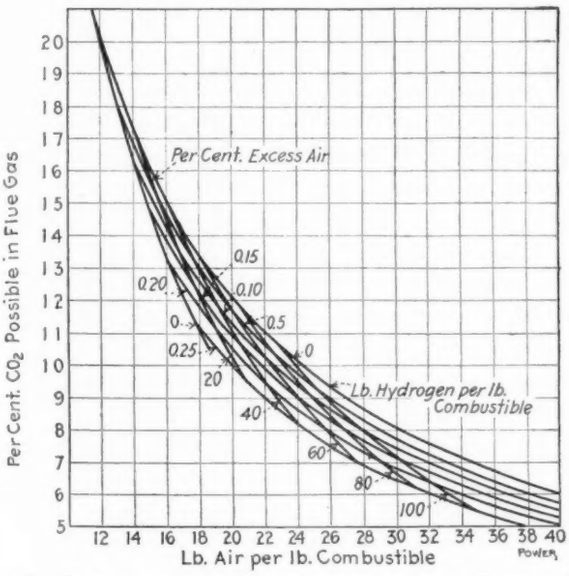



FIG. 3. INFLUENCE OF HYDROGEN, WITH A GIVEN AIR AND FUEL RATIO, UPON $CO_2$ PERCENTAGE

combustible is composed of only carbon and hydrogen. This is true also of fuel gas and fuel oils except for a trace of sulphur.

The hydrogen in the coal combines with the oxygen of the air to form $H_2O$ (superheated steam) which condenses in the Orsat, thus robbing the available total of a certain percentage of oxygen, so that it will be less than 20.9 per cent.

Fig. 1 shows the relation between the amount of air required for complete combustion and the proportion of hydrogen in the combustible. Figs. 2 and 3 show graphically the effects of hydrogen and air supply upon the $CO_2$ percentage. In all three charts the combustible is assumed to be carbon and hydrogen only.

With good steaming coal, from 4 to 5.5 per cent. of the combustible is hydrogen. If there is little nitrogen and oxygen contained in the coal, the totals of $CO_2$ and O in the flue gas will be from 18.5 to 19 per cent; that is, the maximum $CO_2$ available will be 18.5 to 19 per cent.

With good furnace design and operation, the $CO_2$ should average from 12 to 14 per cent. with from 6.5 to 4.5 per cent. oxygen.

Oil fuels usually run about 85 per cent. carbon and 15 per cent. hydrogen. In this case, the available $CO_2$ is not over about 14.5 per cent.

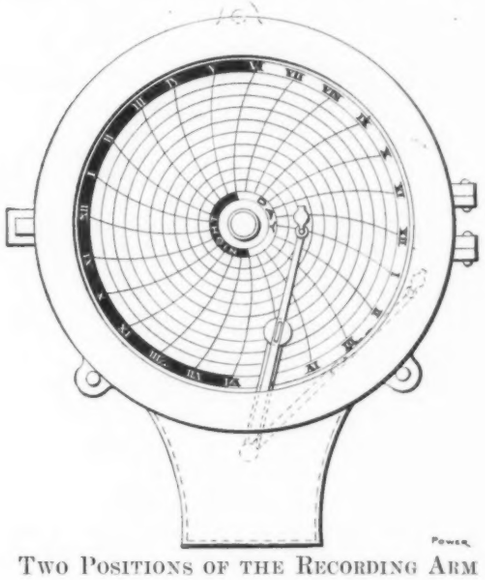
From the combustion of certain natural gases, where H is greater than 30 per cent., the available $CO_2$ percentage is even lower.

Therefore, analyses of flue gas for $CO_2$ under certain conditions may be misleading as indications or measures of furnace efficiency, unless the engineer knows his fuel. The charts shown are intended, principally, as an aid to visualizing the influence of hydrogen contained in fuel upon the results obtained in the ordinary flue-gas analysis.

## New Recorder Pen Arm

Lifting the pen arm from the chart holder of a recording instrument, retaining it in a strained position with one hand, while the chart is changed with the other, requires considerable practice and dexterity to accomplish without spilling the ink or soiling the chart.

The Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.,




TWO POSITIONS OF THE RECORDING ARM

has applied for patents on a new recording pen arm to be used exclusively on their "Columbia" recording gages, recording thermometers and tachometers, that does away with this objection. The arrangement consists of a pen arm proper, its pedestal, and an adjusting screw. The pedestal is directly connected to the recording element of the instrument, which is retained in place by its slight resiliency and with the aid of the pin on the adjusting screw.

When the chart is changed the recording arm is drawn away from the recorder by lifting it from the pin, and is allowed to drop to the right, the pedestal remaining stationary, as shown in the illustration. The obstructing pen arm thus being removed, the chart is easily changed and the recording pen replaced in its proper position.

❖

## Cookson Heater Improvement

The improved body of the Cookson heater is cast in one piece to give greater strength, durability and better appearance. The substitution of a single casting for the built-up plate body does away with bolts and calked joints, except for the oil separator, manhole and handhole covers and the pipe fittings; hence, there is no chance for leakage at the points which in the built-up heater are most apt to give trouble from this source.

This one-piece, cast-iron heater, which is built by the Bates Machine Co., Joliet, Ill., has large steam space, tray surface and filtering space, and the four large manholes and handholes make cleaning easy. The cleaning doors are conveniently located in front and back and as the heater may be made right or left handed by turning half way around, it will fit into the plant without complications in the piping.

The oil separator is made in two types; one is extra large and fitted with a cutout valve, which permits of shutting off the body of the heater for cleaning without interfering with the action of the oil separator.

The second or standard oil separator permits of piping the heater on the thoroughfare or induction principle and eliminates oil from as much exhaust steam as is required for feed-water heating.

A steam trap and return openings are provided so that the heater may receive the returns from a steam-heating system or not as desired.

❖

## Lytton Vacuum Traps Serving Surface Condenser

When an engineer thinks of a surface condenser, he naturally associates with it a circulating and wet-vacuum pump, or a hotwell and dry-air pump. But how many have seen the wet-air pump used as a dry-air pump and the condensate from the condenser handled by one or more vacuum traps?

Although such a combination may appear impracticable, there may be seen in operation day and night, at the Jacob Ruppert Brewery, East Ninety-second St., New York City, either one of the two 1200-hp. Wheeler surface condensers, each piped to an Edwards air pump and two Lytton vacuum traps.

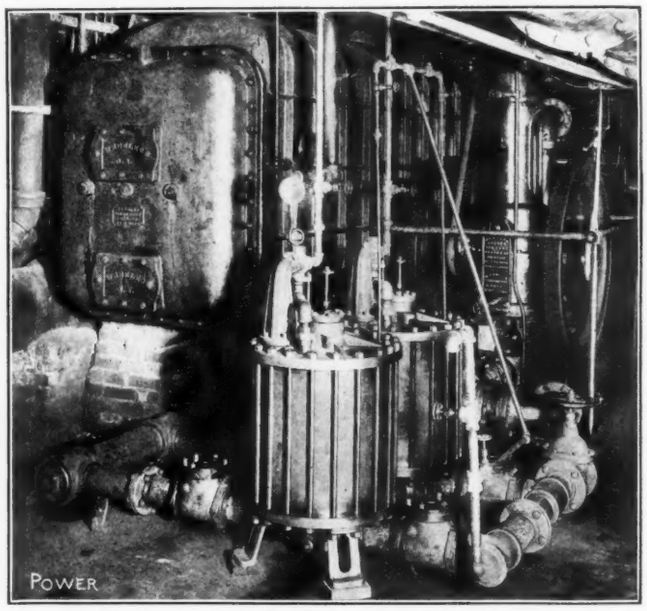
The conditions in this plant are different from those found in the average power plant. It is a refrigerating installation, with auxiliary lighting units. Beside cooling the products of the brewery, ice is manufactured for commercial use, and the problem was how to save the condensate from the surface condensers for making ice.

Originally the condensate was handled by the wet-air pump, but this so mixed the water, air and gas which entered the condenser that the water was worthless for manufacturing ice without further treatment. Various schemes were tried to free the water of air and gas, but without success, until the idea of adopting vacuum traps as a means of handling the condensate was adopted.

The two surface condensers in this plant each contain 1665 three-quarter-inch tubes, 10 ft. 2 in. long. The Edwards wet-air pump was piped to the condenser with a 6-in. nipple extending 4 in. above the bottom of the shell. The two traps were connected to the other end of the condenser at the bottom so that the water flows to them with a small head.

If for any reason both of the traps should fail to operate, the water would collect in the bottom of the condenser shell until it overflowed the top of the projecting 4 in., of the nipple of the air-pump connection. Should this occur, the pump operates as a wet-air pump and would maintain the vacuum and relieve the condenser of water. Under ordinary conditions the pump takes care of the vapor which is not condensed and stands ready to act as an emergency wet-air pump if necessary.

The accompanying illustration shows one of the condensers, the air pump and vacuum traps. Each trap operates at 80 lb. of water per discharge and, when both are in operation, discharges occur between four and six times per minute, depending upon the load on the engine. If for any reason one trap is out of service the remaining trap will operate at a rate of five discharges per minute, but such rapid and severe work is not recommended.




LYTTON VACUUM TRAPS OPERATING WITH A SURFACE CONDENSER

At the time a POWER representative saw the installation, each trap was discharging twice a minute. The trap gage showed a difference in pressure from 1 lb. to 28 in. of vacuum, which represented the discharge pressure and the vacuum on the trap during the discharge and filling periods. The traps are each 24 in. in diameter and 36 in. high. They operate with a consumption of 0.15 lb. of steam per 100 lb. of water discharged. The circulating water enters the condenser at 76 deg., and the outlet temperature is 86 deg. F. The condensate discharged by the trap has a temperature of 86 deg. F.

As the patent arrangements relating to this trap have not been fully made, details of the internal construction cannot be shown, but it is said to be extremely simple.

## American Water Works & Guarantee Co.'s Report

The above company has issued a 60-page annual report containing about 110 illustrations. seven maps and seven pages of statements of constituent companies. The booklet is divided into five sections, representing the company's interests throughout 17 states from the Atlantic to the Pacific, water works, electric railway and power, irrigation, hydro-electric power and industrial.

The latest available information about the properties controlled and operated and about the communities served is given at considerable length. Views in cities having 30 water companies; of the West Penn Traction system and industrial establishments operated in whole or in part by electric power; of irrigation systems in Idaho and California, together with agricultural scenes; of power plants and sites in Idaho, and progress pictures of the Cheat River hydro-electric development in West Virginia; of properties of the United Coal Co. The frontispiece is a picture of Great Shoshone Falls, on the Snake River, near Twin Falls, Idaho. These falls are 212 ft. high, or 55 ft. higher than Niagara, and have been popularly pronounced the most beautiful on the American continent. The maps show locations of the properties and give a general idea of the scope of operations of the parent organization. The booklet is being distributed by J. S. & W. S. Kuhn, Inc., of Pittsburgh, the fiscal agent of the American Water Works & Guarantee Co.

❋

## Exhibition of Power-Plant Specialties at Owen Sound

An exhibit of power-plant specialties and equipment will be held at Owen Sound, Ont., Tuesday, Wednesday and Thursday, July 29, 30 and 31, under the auspices of the Exhibitors' Association of C.A.S.E., when the stationary engineers meet in convention. An interesting program has been prepared for the convention and entertainment for ladies provided, including automobile trips, boat trips, etc.

The headquarters for the exhibitors will be King's Royal Hotel, at King's Royal Park, about two miles from Owen Sound.

❋

## To Aid Exhibitors at the Panama-Pacific Exhibition

In corresponding with manufacturers of machinery and mechanical devices with reference to exhibiting at the Panama-Pacific International Exposition in San Francisco in 1915, the replies indicate that some manufacturers who build minor devices, although of great interest from an exhibit standpoint, cannot bear the expense of maintaining an individual representative in San Francisco during the Exposition period. The department of machinery exhibits will gladly coöperate with such manufacturers to make it possible for them to show their lines at reduced cost in accordance with the following suggestion:

If several such manufacturers will club together and make their individual applications for space for showing their products, and express their desire to have it done, they will be assigned space in such a way that their exhibits may be grouped together, and handled and cared for by one person; in this way the expense can be greatly reduced and the effectiveness of the exhibit enhanced. If this is done, each exhibit will be considered by the jury for awards in the same manner as if handled independently. It would perhaps not be wise to include in any group directly competitive articles, but it should be possible to work out groups of devices which are more or less related to each other, and yet do not come into direct competition.

As a concrete example, take a manufacturer whose work is confined almost exclusively to the making of ball bearings. An exhibit in which the ball bearings of all different forms and styles constituted the central feature might have grouped around it a number of other devices or machines in which the ball bearings are used, such as ball-bearing jacks, etc.

Similarly accessories of correlated kinds might be grouped together and the individual expense reduced.

The department of machinery exhibits will be pleased to hear from any persons who are interested in such a plan, and will cheerfully furnish any information possible to aid or assist intending exhibitors.

## BOOKS RECEIVED

THE FITTING AND ERECTING OF ENGINES. By C. Leslie Browne. Emmot & Co., Ltd., Manchester, England, Cloth; 153 pages, 5¾x8¾ in.; illustrated. Price 3s. 6d.

PRACTICAL ALTERNATING CURRENTS. Fifth edition. By Chas. F. Smith. The Scientific Publishing Co., Manchester, England. Cloth; 398 pages, 5½x8½ in.; 258 illustrations; tables. Price 6 shillings.

ENGINEERING TABLES AND DATA. By W. W. F. Pullen. Third edition. The Scientific Publishing Co., Manchester, England. Cloth; 68 pages, 5½x8½ in.; tables; illustrated. Price 1s. 6d.

LOGARITHMS FOR BEGINNERS. Fourth edition. By Charles N. Pickworth. D. Van Nostrand Co., New York. Cloth; 49 pages, 5x7¼ in.; tables. Price 1 shilling.

STEAM POWER PLANT ENGINEERING. Fourth edition. By G. E. Gebhardt. John Wiley & Sons, Inc., New York. Cloth; 989 pages, 6x9¼ in.; 608 illustrations; chart. Price $4.

THE NEW STEAM TABLES. By C. A. M. Smith and A. G. Warren. D. Van Nostrand Co., New York. Cloth; 101 pages, 5½x8½ in.; plate; tables. Price, $1.25.

THE MOTOR AND THE DYNAMO. By James L. Arnold. The Chemical Publishing Co., Easton, Penn. Cloth; 178 pages, 6x9 in.; 166 illustrations. Price, $1.50.

GAS ENGINES AND PRODUCERS. By Lionel S. Marks and Samuel S. Wyer. American School of Correspondence, Chicago, Ill. Cloth; 62 pages, 5½x8½ in.; illustrated.

## NEW PUBLICATIONS

PRACTICAL MATHEMATICS. By Claude Irwin Palmer, Assistant professor of mathematics, Armour Institute of Technology. Published by McGraw-Hill Book Co., New York. Size 4½x7 in.; 147 pages, illustrated, cloth. Price $1.75.

This volume treating the subject of trigonometry and logarithms is the last of a series of four volumes on the subject of Practical Mathematics. The other three volumes deal with arithmetic, geometry and algebra respectively.

The series is the outgrowth of a course in practical mathematics given in the evening classes of the Armour Institute of Technology. The purpose of these volumes is to present to the ordinary tradesman the means for obtaining a working knowledge of the mathematics he requires in his work. Numerous practical examples are used as a means of presenting methods for working in the various branches of mathematics covered by the series.

---

A PRIMER OF THE INTERNAL COMBUSTION ENGINE. By N. E. Wimperis. Published by D. Van Nostrand Co., 25 Park Place, New York City. Cloth, 5x7 in.; 143 pages, illustrated. Price, $1, net.

As the author states at the outset, this little book is intended chiefly as an introduction to his textbook on "The Internal Combustion Engine." In this way the larger work is not encumbered with the more elementary considerations, and those who do not care to go deeply into the subject will find sufficient in the "Primer" to give them a general knowledge of internal-combustion engines.

An introductory chapter is devoted to a brief history of the internal-combustion engine, and this is followed by chapters on the theory of heat, gases and vapors, the ideal engine, the real engine, fuels and gas producers, engine details and engine tests. Of course, only the high points are touched under each item.

The text has been prepared with a view to its use in the classroom, which fact explains the employment of calculus in the chapter on gases and vapors. Numerous examples are also included and the answers are given at the back of the book.

---

GAS ENGINES AND PRODUCERS. By L. S. Marks and S. S. Wyer. Published by the American School of Correspondence, Chicago, 1913. Size 8x5½ in.; 213 pages, illustrated. Price $1 net.

This is one of a list of handbooks which the American School of Correspondence has got out for home study to meet the needs of those who do not find it convenient to take the correspondence course. The book comprises two principal divisions—the first dealing with gas and oil engines prepared by Prof. Marks of Harvard and the second on gas

producers by Samuel S. Wyer, the well known authority on that subject.

No attempt has been made to go deeply into the mathematics of the subject, outside of a simple treatment of the thermodynamics of the Otto cycle; nor have the finer points of design been taken up—an omission very commendable in a book of that kind. Instead, the text is largely descriptive and in this respect undoubtedly covers more types of engines and producers than any other book of its size. Owing to the importance of the Diesel and semi-Diesel engines, however, we believe the authors could have profitably devoted more space to these types. There appears a slight repetition concerning gas engine fuels and producers in general as these are covered in both the gas engine and producer sections. This is probably due, however, to these sections being prepared by different authors.

Briefly, the main divisions of the subjects covered are: A historical sketch of the internal-combustion engine, the modern gas engine including valves and valve gears, thermodynamics of the Otto cycle, ignition, governing, starting, water jackets, large gas engines, kerosene and crude-oil engines, manufacture of producer gas, gasification losses and producer testing, representative types of producer-gas cleaning and producer-gas power plants.

The text is written in a simple but interesting style and is well illustrated. A careful perusal of the book should afford one a very good knowledge of the subject in general.

---

THE D'ESTE STEAM ENGINEER'S MANUAL. By Julian D'Este with an Electrical Appendix by Charles Penrose. Published by the Julian D'Este Co., 24 Canal St., Boston, 1913. Size, 5x7 in.; 493 pages, flexible leather. Price, $2 net.

This, the second edition of the manual, embodies much new matter not found in the original edition and besides, an electrical appendix of 356 pages. Although the electrical part takes up more space than that devoted to steam engineering, the title is not as misleading as might appear at first glance, for the electrical matter has been selected largely to meet the needs of the steam engineer.

The first part of the book is devoted to a brief review of mathematics and contains numerous useful tables and formulas. Very useful information is given on boiler settings, evaporative tests, pumps, the care of steam boilers and setting up stationary engines. Also, the engineer is shown how to figure riveted joints, the strength of boiler shells, strength of stays, bursting stresses in flywheels, areas of safety valves, etc.

It is to be regretted that the author, in revising the work did not incorporate the Marks and Davis steam tables instead of adhering to the old values and he might well have given more space to the broad subject of internal-combustion engines, and to mechanical refrigeration and ice-making, especially since a great many steam plants now contain refrigerating machinery.

The electrical matter is excellent and contains just the information that the operating man desires regarding the care and operation of the usual electrical apparatus. In this the numerous wiring diagrams should prove helpful. Chapters are also devoted to thermo-electric pyrometry, standard cells, measurements of electromotive force and illumination.

About 50 pages are devoted to illustrating electrical generating machinery and another 30 pages to views of typical generating stations in the United States. This is followed by a synopsis of the electrical equipment of a typical alternating-current generating station.

The book should prove a valuable aid to the operating engineer.

## SOCIETY NOTES

It has been decided to make the Hotel Schenley the headquarters of the Illuminating Engineering Society convention, which will be held in Pitsburgh, Sept. 22-26. The hotel is in a popular residence section, within easy walking distance of the Carnegie Museum, the Library, Carnegie Technical Schools, University of Pittsburgh, several prominent clubs and the Soldiers Memorial Hall. The last-mentioned building will prove of particular interest to illuminating engineers because of its wonderful lighting, said to be unequalled anywhere in the United States.

The program as now outlined covers an exceedingly interesting set of papers on illumination.

In addition to the technical sessions, the local committee has arranged for a series of entertainment features, in which the ladies are included, covering golf, tennis, baseball games, automobile rides, theater and card parties, and conclude with a banquet at Hotel Schenley, at which some innovations are promised.

Inspection trips have been arranged to several industrial plants including the Westinghouse Electric & Manufacturing Co., Macbeth Evans Glass Co., and the Carnegie Steel Co.; also a luncheon at the H. J. Heinze Co., the home of the 57 varieties, for the ladies.

The papers as now scheduled include, among subjects, the "Quartz Light, Fontune, and Neon Tube"; "Church, Factory, Store, Hospital and Street Car Lighting"; "The Present Commercial Development in Several Forms of Lighting"; "Errors in Photometric Measurement," and the "History of Artificial Lighting."

The development of the new flame-carbon arc lamp will also be discussed by representatives of the manufacturing concerns.

An interesting feature of the technical sessions will be the holding of symposiums on the various general subjects to be led by those particularly well posted. These meetings will afford open discussion.

A transportation committee has been appointed, including the secretary of the local section in each city, which will perfect arrangements for the members and friends in obtaining transportation to and from Pittsburgh.

---

The sixth annual excursion of the Combined Association of Engineers of Brooklyn, N. Y., took place on Sunday, July 13. About 2000 engineers and their friends boarded the steamboat "Adonis" and barge "Sparina" from Jewell's wharf. A sail of 40 miles up the Hudson River was made, during which dancing was enjoyed. The excursionists stopped at Forest View Grove, returning to Brooklyn at eight o'clock. The several committees are to be congratulated.

## PERSONALS

J. F. Nagle, chief engineer of the Kenogami and Jonquiere Paper Mills of Price Brothers & Co., and lately chief inspector for the New York Steam Co., has been promoted to the position of supervisor of power plants for the above company with headquarters at Kenogami, P. Q., Canada.

B. S. Rederer has opened an office at 518 Park Building, Pittsburgh, Penn., for the sale of power-plant equipment. He will represent the Brownell Co., Dayton, Ohio, W. K. Mitchell & Co., Inc., Philadelphia, Penn., Canton Grate Co., Canton, Ohio and the Burt Manufacturing Co., Akron, Ohio.

C. V. Kerr, formerly chief engineer for McEwen Bros., Wellsville, N. Y., has severed his connection with that company after 3½ years' work in developing a helical pump and a propellor blower. He is now engaged in the private development of a group of turbine-driven power-plant auxiliaries.

Dean W. F. M. Goss, of the College of Engineering, University of Illinois, has been unanimously elected chief engineer of the committee on smoke abatement and electrification of railway terminals of the Chicago Association of Commerce. Dean Goss will succeed Horace G. Burt, who died recently. In order that he may take up the work without interruption, he has had granted to him by the University of Illinois a leave of absence for a year.

John F. Duffey, treasurer of the Scandinavia Belting Co., has just returned from a month's trip abroad having visited the company's mills at Yorkshire, England. Mr. Duffey reports that the large volume of business this company has enjoyed has compelled extensive additions to the present works, making the third within the last five years. Mr. Duffey also states that the policy of the Scandinavia Company is such that the factory help is given many comforts, such as recreation grounds, etc., a large dance hall and employees' dining room being a part of the factory. The office in London occupies four floors devoted exclusively to the selling of textile beltings. The factory equipment is of the latest type.

## OBITUARY

William Finney, head of the boiler manufacturing concern of Finney & Hoffman, died at his home in Brooklyn, N. Y., on July 7. Mr. Finney was 81 years of age.